AN ANTHROPOLOGICAL EXPLORATION OF THE EFFECTS OF FAMILY CASH TRANSFERS ON THE DIETS OF MOTHERS AND CHILDREN IN THE BRAZILIAN AMAZON

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The Bolsa Família program (BFP) has reached almost a quarter of the Brazilian population. The program targets households in extreme poverty through direct cash transfers from the federal government. Essentially, debit cards are issued, preferably to mothers in a household, and monthly cash transfers are made on the condition that their children meet education (minimum school attendance) and health requirements (vaccinations). Since its inauguration in 2003 (current incarnation), there have been many evaluations of the BFP concerning its impact on child nutrition, which have yielded inconsistent results. Evaluations have raised questions about the use of funds for competing households needs and the BFP's role in contributing to a "nutrition transition" trend (Popkin 1994), with direct impacts on the quality of children's diets (Ibase 2008). Chronic child malnutrition has been widely assessed in the rural Brazilian Amazon and consumption of processed foods is on the rise (Piperata 2007). However, agricultural production still contributes to a large portion of the diets, and children are active in procuring foods (Smith et al. 2007). In this context, this research investigates household management of the BFP-benefit, testing if management features are associated with food provisioning, intake of processed foods, and health status. Moreover, it addresses the effect of BFP participation on mothers' diets. The research has a longitudinal design, using mixed methods (e.g. ethnography, household money management interviews, 24-hour dietary recalls, and anthropometry – the last two repeated three times during the year); and a case control, including non-BFP participants (census interview and food frequency questionnaire). The dissertation chapters address the historical and socio-cultural context of the communities studied; environmental variables associated with fluctuations in diets; BFP participation and its associations with consumption of processed foods and food production; and BFP cash-benefit management and its associations with health variables.

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INTRODUCTION TO THE DISSERTATION

RESEARCH PROBLEM

The Bolsa Família program (BFP) is the largest conditional cash transfer (CCT) policy in the world. In 2016, the BFP reached almost a quarter of the Brazilian population, at a cost of approximately 95 billion dollars (309.58 billion *reais*) to the government (MDS 2016). Essentially, the program consists of direct money transfers from the national government to families in extreme poverty, based upon their compliance with certain child education and health conditions. The program also provides cash transfers to extremely poor families with no children. The BFP evolved from smaller municipal initiatives which introduced conditions and compliance linked to monthly cash transfers (Zimmermann 2006). A 2004 law instituted the BFP program in its current form, under a framework of hunger eradication, by unifying and expanding the management and implementation of existing social programs including *Bolsa Escola*, *Bolsa Alimentação*, and *Auxílio Gás* (Casa Civil 2004, 836). In Latin America, CCT policies appeared with great anticipation, conceived as a strategy to address poverty, food insecurity, education, health and gender inequality, and the BFP is frequently used to exemplify this success (Lindert et al. 2007; Lomelí 2008; FAO 2015).

After more than a decade of implementation, there have been many impact evaluations focused on child education and nutrition. Some of these studies have exposed operational problems in the program, including inefficient supply of services for compliance, and errors in assessing participants' eligibility criteria (Hall 2006). Nonetheless, there is a clear increase in the use of education and health services, and access to consumer goods, but there are mixed results for improvement in child nutrition (Bassett 2008, Hoddinot 2010). Moreover, participating families report an increase in the variety of foods consumed and in the amount of food purchased, but studies suggest these are mainly processed food items (Ibase 2008, Paes Sousa 2011). These results come from evaluations using structured interviews with country-level samples, despite differential impacts throughout the country.

In many rural communities in Amazonas state, children have historically suffered from chronic malnutrition (Alencar et al. 2007), and recently, an increase in the consumption of processed foods has been documented (Piperata et al. 2011; Nardoto et al. 2011; Piperata, McSweeney, and Murrieta 2016). Monteiro et al. (2011) stresses that processed foods represent the core items of a low-quality diet. However, in rural areas, agricultural production may still contribute to a large portion of the daily diet and children are known to be active in procuring foods from forests and garden lots (Smith et al. 2007). At the same time, based on a longitudinal study and ethnographic work, Piperata, McSweeney, and Murrieta (2016) argue that in the context of rural communities in the state of Pará, household food security deteriorated after the implementation of the Bolsa Família. According to them, this deterioration is mostly mediated by a decline in community cooperation and the abandonment of manioc fields, changing the behaviors and aspirations of younger generations.

The publicity and positive appraisal, as well as demonizing of the BFP among academics and practitioners (e.g. Fiszbein et al. 2009; Freeland 2007) rests on top of a knowledge hole, at least when considering nutrition and health of Amazonian rural populations. In the Amazon, researchers recognize this weakness, proposing a research agenda including the analysis of household variables and taste preferences (Lima 2010), as well as physical activities patterns (Dufour and Piperata 2008), and disease burden settings (Silva 2009; Tanner et al. 2009), considering compounding effects of the socio-economic stressors (Silva et al. 2016). Moreover, in light of the works on “the meanings of money” (Zelizer 1989; Wilk 1993; Carruthers 2010), the program has the potential to drastically change the dynamics of household economics, given that a cash transfer directed to women and children may represent a “special money” with a specific purpose.

Given this scenario, in the context of the Amanã Reserve in the rural Middle Solimões area, this dissertation investigates two main questions, developed into a number of sub questions:

1) Is there a correlation between types of BFP funds management in the household, and nutrition and health status of women and children? If so, how do we understand the dynamics of these correlations?
    a. How are BFP funds managed in the household?
        i. How do women make decisions about the expenditure of BFP funds in the household?
        ii. Are BFP funds used as a personal money for women in the household, given that the BFP regulations state that the fund should be “preferably transferred to women?”
        iii. Or, are these funds managed jointly, by the couple of the household nuclear family?
    b. How do households spend funds from the BFP?
        i. Is expenditure tied to a specific purpose set beforehand?
        ii. Or, is the money added to a general household fund used for diverse expenditures without any specific separation?

c. Do the types of management differ according to household income?

d. Are the types of BFP fund management associated with certain expenditures?

    i. Are the funds being spent exclusively with food?

    ii. Or, are there a diverse array of items being purchased with the BFP funds?

e. Are types of management associated with positive or negative nutritional and health status outcomes for mothers and their children?

    i. Do these outcomes differ between adult women and adolescents?

    ii. Do they differ by gender, in the case of adolescents?

2) How is participation in the BFP program affecting the diets of women living in Amanã?

    a. Are BFP participant women consuming industrially processed foods more frequently than non-BFP recipient women?

    b. Are BFP participant women consuming community-produced foods less frequently than non-BFP recipient women?

    c. Does age play a role in increasing or decreasing the frequency in consumption of industrialized foods by BFP-participants and non-participants?

    d. Does the inclusion of industrialized food items characterize a shift in the structure of diets, or more an addition of items?

Considering that the historical and socio-economic contexts are important aspects of individual's nutrition and health outcomes, I also focus on contextual variables to address the specific research questions above. In Chapter 1 I describe the history of creation of the Amanã Reserve, the presence of the Catholic Church and of the Mamirauá Institute for Sustainable Development (IDSM), and gender relations. I also address issues of positionality, as well as bringing an emic perspective using narratives and photographs produced by adolescents living in Amanã (as part of the photovoice project). In chapter 2 I analyze the food culture in Amanã as this is an important contextual variable in which the environment plays a crucial role. The focus of this chapter is to address the question of fluctuation of macronutrients in diets during different seasons and according to age and gender (for adolescents). In the same chapter I also discuss how parasitic infections and nutritional status differ according to age and gender (for adolescents), in the context of productive activities and routines of women and adolescents living in Amanã.

BACKGROUND: LOGICS BEHIND THE BFP

The logic of conditional cash transfers (CCTs) originated in a new approach to development policies, in which the extremely poor are seen as hindered by uncertainties and unable to plan for the future (Banerjee and Duflo 2011). This is quite different from an approach that shows a "tendency to dismiss the behavior of poor people and ethnic minorities as 'irrational'" (Wilk and Cliggett, 2007: II). To its proponents, CCTs provide a steady income flow, linked to long-term goals. From a managerial standpoint, CCTs are more cost-effective than commodity-based aid, such as food stamps (Hall 2006). In the case of the BFP, beneficiaries receive a debit card and a pin number, and the benefit is withdrawn as cash.

Eligible families make roughly 35 USD (R$70) or less per capita monthly[1]. The maximum amount a household can receive is the equivalent of 153 USD monthly, calculated based on income-level and composition (targeting households with children less than 17 years of age and pregnant women). There is no condition for use of the money, eliminating the creation of informal markets, and reducing administrative costs (Hall 2006). Moreover, transfers are made preferably to mothers, under the assumption that they "provide the means to increase food availability at the household level" (Hoddinot 2010: 237).

Impact evaluations of CCT programs have flourished since their creation, especially in regards to food consumption and nutrition (Ibase 2008, Vaitsman and Paes-Souza 2007, Hoddinott 2010, Paes Sousa 2011). The vast majority of these studies uses structured interviews, and results do not show any significant improvement in children's nutritional status (Manley et al 2013). Moreover, few look at variables related to household income and management of the BFP-benefit. Some exceptions include the work of Piperata et al. (2011) in inland communities in the Brazilian Amazon (Pará state), who looked at the sources of income, asserting that the BFP benefit was the "most noticeable change to household income discussed by local people" (Piperata et al. 2011: 460). They compared food intake of women in 2002 (30 subjects) and 2009 (52 subjects) and identified an increase in the consumption of processed meats and refined carbohydrates in that period. They also found a negative relationship between manioc cultivation and reliance upon purchased foods. In contrast, a study by Lima (2010) in riverine communities in Amazonas state, shows that while sales of manioc flour have

[1] Figures from January of 2014, period of initial fieldwork. In May of 2014 the criteria to determine extreme poverty changed from 70 BRL to 77 BRL per capita (Decreto 8.232 2014), and in June of 2016 from 77 BRL to 85 BRL (Decreto 8.232 2016).

decreased, fishing activities have increased. Her conclusions are based on household budgets collected in 1995 and 2005. Lima (2010) speculates that there is a possible diet-related mechanism, with taste and cultural preferences playing an important role behind these changes. She calls for further ethnographic work therein. Until now, research has provided mixed results, yet studies have noted a relationship between household income and food provisioning.

BOLSA FAMÍLIA RULES AND REGULATIONS

The eligibility criteria for participation in the BFP is the following: 1) households with income up to approximately 35.00 USD per capita per month; and 2) households with income between approximately 0 USD and 70.00 USD per capita having children or adolescents between zero and 17 years of age or pregnant women[2].

Currently, there are four types of benefits available, which can be combined (up to a total of about 153 USD only for basic and variable types) depending on the household composition and income level. The four types are:

1) Basic (*Benefício Básico*), which is provided to families in situation of extreme poverty, independently of the household composition (benefit equals approximately 35 USD/month);
2) Variable (*Benefício Variável*), which is provided to families in situation of poverty or extreme poverty, with a household composed of pregnant women, or women

[2] All figures included here considered the exchange rates from January 2014 when I started fieldwork. Although the BFP criteria to define extreme poverty per capita by income increased in BRL, the USD equivalence decreased due to the Brazilian currency devaluation. In 2014, during the fieldwork period, there was a 13% devaluation, with the political crisis and economic recession the decrease in 2015 was of 47%, and 2016 saw a slight recover of 16%, in comparison to the American dollar (Banco Central do Brasil 2017).

nursing, or children between zero and 15 years old. Each family may accumulate up to approximately 80 USD of the variable benefit (approximately 15.50 USD to each "target category" family member);

3) Variable for youth (*Benefício Variável Vinculado ao Adolescente*), which is provided to families in a situation of poverty or extreme poverty, with a household composed of adolescents between 16 and 17 years old. Each family may accumulate up to approximately 76 USD of the variable for youth benefit (approximately 19 USD to each "target category" family member); and

4) Extreme Poverty Overcome During Infancy (*Benefício para Superação da Extrema Pobreza na Primeira Infância*), which is provided to families in a situation of poverty or extreme poverty, with a household composed of children zero to 15 years old. Each family may receive only one Extreme Poverty Overcome During Infancy benefit.

The BFP is a federal program managed at the municipality level. It is up to the municipality to perform the registration of families, through the Unified Register of Social Programs of the Federal Government (*Cadastro Único*). The selection of households, however, is made by the Ministry for Social Development and Combatting Hunger (MDS).

PERSPECTIVES INCLUDED IN THE ANALYSIS

The focus of this research is at the intersection between two global trends: first, the spread of CCTs to address fundamental problems of economic inequality and social. Second, the nutrition transition, identified as a diet shift "towards increased reliance upon processed foods, increased away-from-home food intake, and increased use of edible oils and sugar-sweetened beverages". The broader aim of this research is to bring evidence and elucidate the mechanisms through which outcomes of these trends are present or not, in the context of the rural Brazilian Amazon. Specifically, this research is framed using theories surrounding these two global trends, CCTs and the nutrition transition, with an anthropological and interdisciplinary approach.

The conceptual framework informing this research is presented in Figure 1. The framework grounds these global trends, using the household and individuals as the units of analysis, while at the same time, paying attention to the contextual and historical developments in the region. To accomplish these goals, this study describes the context of Amanã, placing it in studies of Amazonian peasantry and describing the history of economic and social development in the Middle Solimões (Chapter 1). I also acknowledge the influence of the landscape on residents' identities (Chapter 1), with human-environmental interactions at the core of the analysis, present in various chapters, for instance when discussing seasonal variation in diets, partly as a function of the availability of natural resources (Chapter 2). Anthropological theories on diets and cuisine are also outlined in Chapter 2.

Zooming in on the household, I bring in theories of economic anthropology, particularly the study of peasants and household economics, as well as concepts from other disciplines, such as special moneys from sociology, and prospective theory in behavioral economics (Chapter 3). The analysis builds upon a long history of human ecological research in the Amazon, including early studies addressing social development associated with nutrition and health (Chapter 4). At the individual level, I integrate theories and methods of nutritional anthropology and public health. This integration allows for an understanding of dietary shifts, elucidating some of the relationships between diets and physical status, as a function of drawing together ethnographic data on foodways, photovoice accounts related to food attainment and preparation, 24-hour dietary recalls, sources of foods in diets, anthropometric data, and data on intestinal parasitic infections. Nutritional anthropology is discussed in detail in Chapter 4, and to conclude, the intersections between poverty and nutritional anthropology are brought together in Chapter 5.

CONCEPTUAL FRAMEWORK

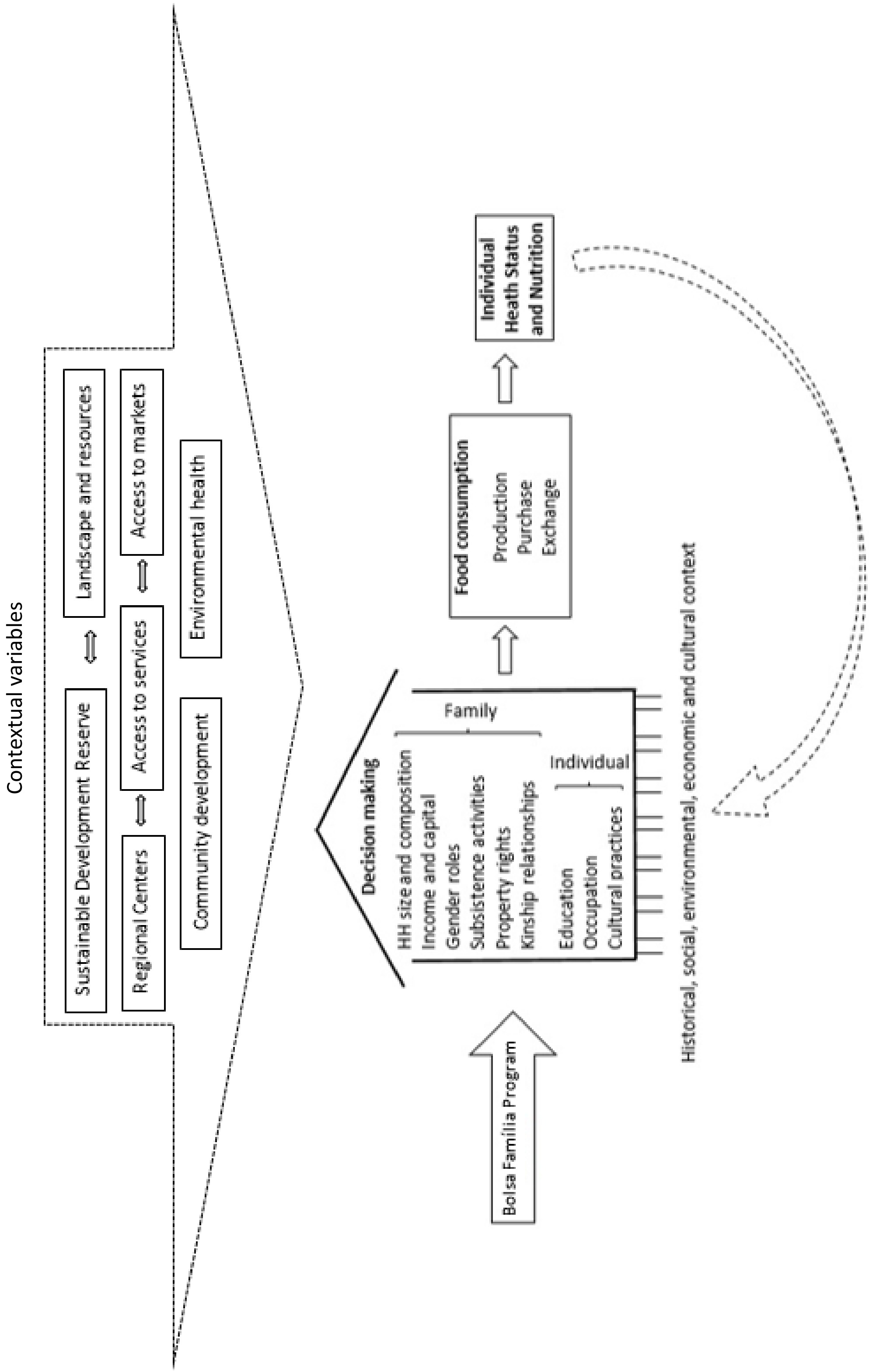


Figure 1. Conceptual framework from anthropological theories applied to this research

RESEARCH DESIGN AND METHODOLOGIES

This research was conducted with populations living in the Middle Solimões River region, more specifically the Amanã Sustainable Development Reserve. A Sustainable Development Reserve (SDR) is a category within the Brazilian National System for Nature Conservation Units described as “a natural area inhabited by traditional peoples, whose life is based on sustainable use of natural resources, developed through generations and adapted to the local ecological conditions, performing the fundamental role of nature protection and maintenance of biological diversity.” The Amanã RDS comprises 2,350 thousand hectares of upland and floodplain forests, with annual water level fluctuation of 9-10 meters on average. It has a population of 3,860 (2011 census, Instituto Mamirauá) distributed throughout 80 villages or localities (3 or less households settlement).

Data collection in Amanã was conducted between February 2014 and March 2015, as well as on a second trip at the end of 2015, in which I collected stool samples for the analysis of intestinal parasitic infections, and conducted monitoring for the continuation of the photovoice project. Two research designs were used to address the research questions, using a primary sample and a secondary sample.

All villages and localities where this study was conducted are located on the western border of the Amanã Sustainable Development Reserve, on or near the Japurá River (Figure 2).

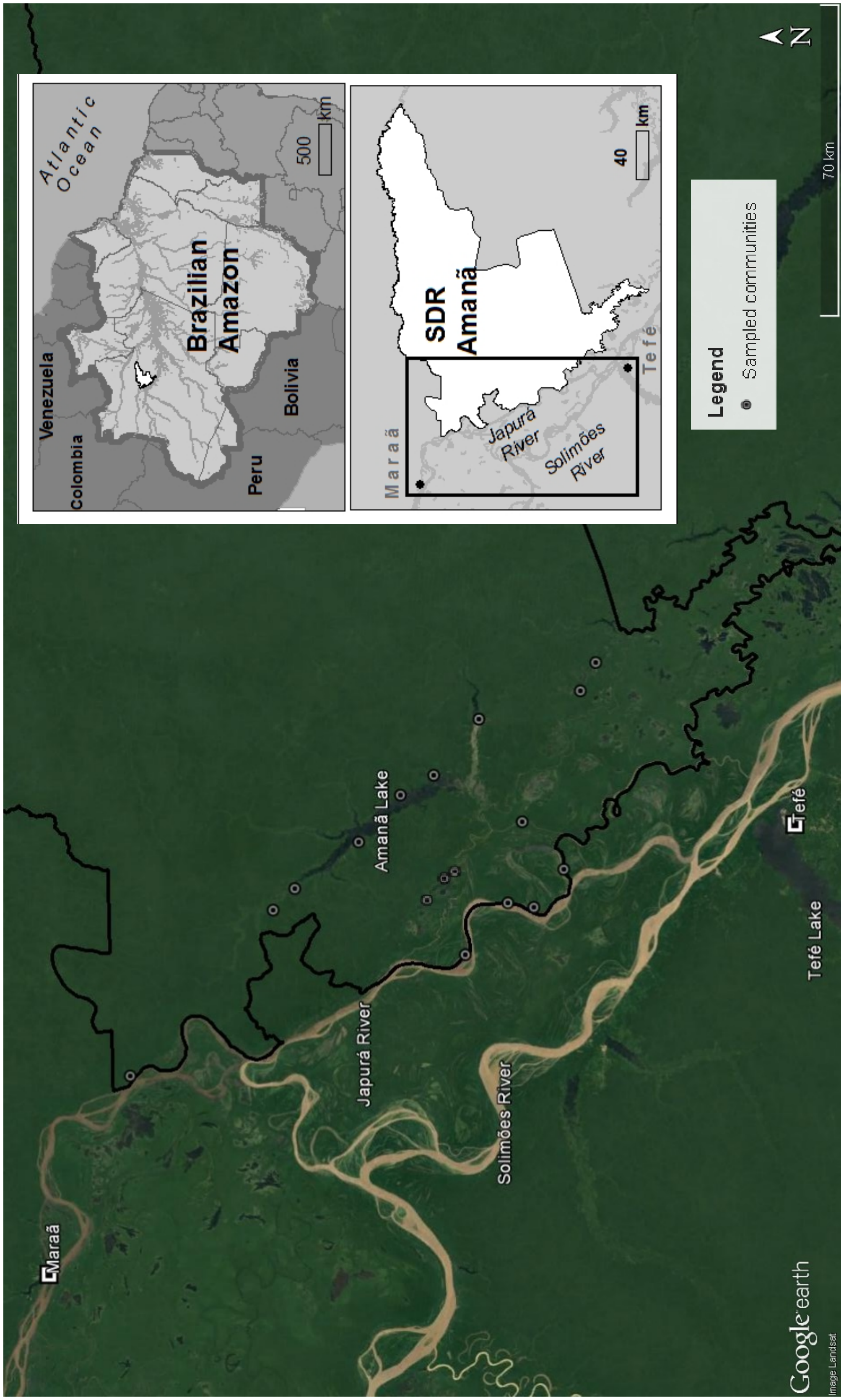


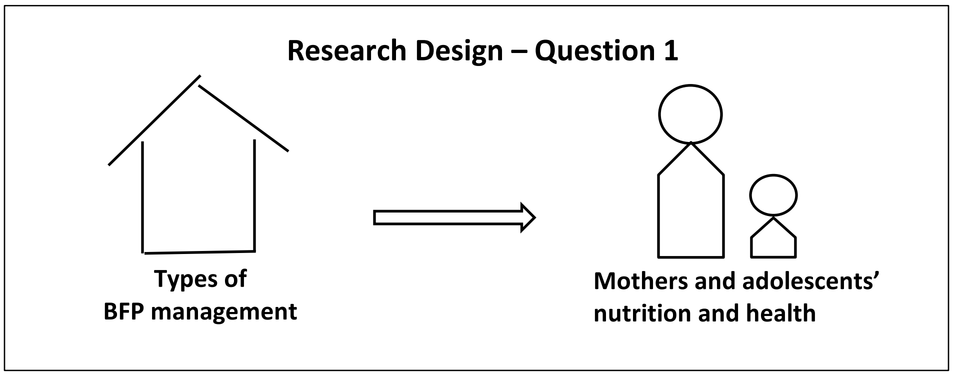
Figure 2. Map of study sites in Amanã Sustainable Development Reserve (RDS).

The town of Tefé was the most commonly visited, as it is larger than Maraã and hosts more services. Less frequently, residents were required to visit Maraã, especially to process paperwork linked to their municipality of residency (e.g. applying for jobs at the community school–the case for all communities in the primary sample).

From communities in the primary sample, it would take about 15 hours or so to get to the town of Tefé by boat or motorized canoes. Depending on the water level of the river the time would increase or decrease by a few hours. The trip becomes shorter during the flooding season as the high-water level creates shortcuts where canoes are able to pass (*furos*), whereas during the dry season people tend to navigate in the deeper parts of the river in order avoid getting trapped in vegetation or debris. Residents take the Japurá River, which then merges with the Solimões, near the town of Tefé (Figure 2).

The primary sample is composed of households and household members (women and adolescents between 12 and 16 years of age) located in three communities and localities (nearby locations with less than 3 households) near the Coraci River. All households participate in the BFP. The main research question addressed with BFP participants investigate whether there are correlations between household money management, particularly Bolsa Família benefit management and expenditure, and the physical and nutritional status of mothers and adolescents. The key variables investigated are related to household money management of BFP funds, as well as detailed dietary and anthropometric data. Therefore, this first research design below addresses research question 1:

1) Is there a correlation between types of BFP funds management in the household, and nutrition and health status of women and children? If so, can we understand the dynamics of these correlations?



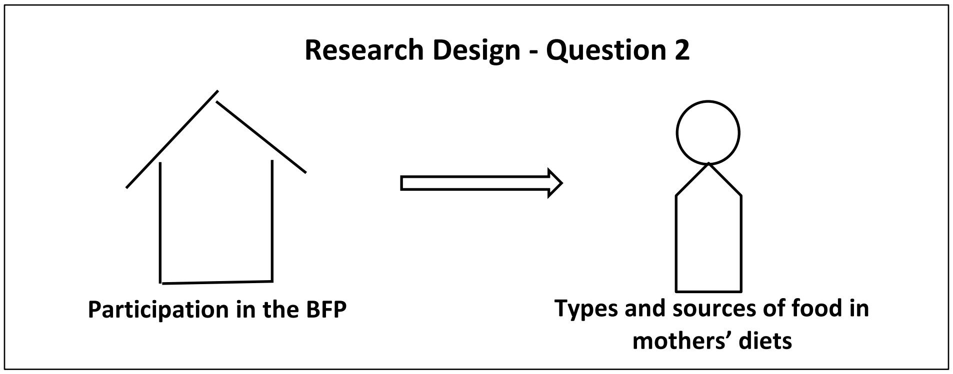
Research conducted with participants in the primary sample is ethnographic since I spent long periods of time living with families in their households, observing and participating in daily activities. Data collection regarding nutrition and health data was longitudinal, given that there were three data points in time, during the flooding, dry, and transition season.

The communities in the primary sample are geographically very close to one another. During the dry season one can walk between two of them in about 15 minutes, and the furthest one is about the same time distance in a motorized canoe. Transit between them is frequent with children coming in everyday to attend school, as well as people meeting to work together in manioc fields, play soccer in the evenings, participate in meetings, see relatives, and so on. There is a historical sense of community in this area tied to people's family ties and identities, which is outlined in detail in the next chapter. For the primary sample, community differences were not considered as important sources of variation in analysis because of the easy access and constant relationship between households and residents.

Moreover, income was only assessed for households in the primary sample, and was calculated based on information from census interviews, participant observation, and triangulation with available governmental data. Social benefits (including the BFP) and wages were used as proxies for income, given that income from agricultural production and fishing, as well as other income sources, such as occasional jobs in construction of houses or boats, fluctuate greatly throughout the year or month. Also, the literature of the region emphasizes that social benefits represent the most significant part of the household income (Peralta and Lima 2014). A detailed description of the sources of income considered in this analysis are found in the methods section of Chapter 3.

The secondary sample includes data collected with the primary sample for the dry season, and includes additional data collected during the dry season for non-BFP participant households (control group). These non-BFP participant households are dispersed throughout the Amanã Reserve, and, there was a maximum of three non-BFP participant households per community (for the communities visited). The methods used for data collection with participants for households of non-BFP participants were all performed at a single interval (during the dry season), whereas with the primary sample longitudinal data collection was carried out. The main research question addressed using this additional research design, which included a control group, concerns the effect of participation in the BFP on the types and sources of food items consumed by women residing in Amanã. Therefore, this second research design addresses question 2:

2) How is participation in the BFP program affecting the diets of women living in Amanã?



The units of analysis were defined based on the descriptions of the BFP itself, as well as on the research limitations in terms of financial resources and time from researchers and respondents. The household unit was defined following the BFP description : "the nuclear family composed of one or more individuals, including any extended family who contribute to the household income and have their expenses served by the family group, residing on the same household (MDS 2007)." While some problems can arise from this definition, including how much of the contribution and deduction to and from the household income includes or excludes a member, this general definition was used as a guideline and time spent living with the nuclear family in the household was used to define a boundary. These issues are discussed in detail in the following chapters.

The individual participants, mothers and adolescents, were chosen following BFP's specified target populations, as well as because of methodological and ethical limitations. As mentioned in the section entitled "Background: logics behind the BFP," the BFP regulations state that the cash transfer should be made preferably to a woman in the household, operating under the premise that mothers will spend the cash with items to benefit all household members. Therefore, mothers were the ones interviewed about the dynamics of money management in the household, as well as expenditure of the BFP-benefit. A focus on adolescents, as opposed to younger children, permitted an investigation of agency in negotiation of the BFP expenditure, as well as for food procurement. Many of the key methods used to measure diet and health outcomes required significant time and commitment from the researcher and respondents. Given these limitations only women and adolescents were included as participants. While data from adult men and young children would contribute to the understanding of the effects of the program on the health of adults and children, time and financial limitations were a constraint. Moreover, the methods would have to be adapted in order to conduct the study with younger children - Burrows et al. (2010) show that children older than 12 years old are more accurate self-reporters of dietary intake. In addition, the study would be more time intensive, and require further approval from the ethics committees, given that young children are considered a vulnerable population.

All communities studied in this research, including households in the primary and secondary samples, were located inside the Amanã Sustainable Development Reserve. The research was approved by the Indiana University Institutional Review Board (study number 1308050454), as well as by the Ethics Committee of the Mamirauá Institute for Sustainable Development (protocol 017/2013), located in the town of Tefé, Amazonas, Brazil.

The methods and samples used in each of the research designs are explained in detail throughout the chapters, according to the data analyzed in each one, and are summarized here (Table 1). Ethnographic data was used in all chapters, including anecdotal descriptions of my conversations with adult women and men in the communities, and my endeavors in participant observation in adults and adolescent's daily activities. Chapter 1 delves into the photovoice results and methods used, the latter included in the Appendix section, while chapter 2 has a description of participant observation. The photovoice method was included as part of the ethnographic work, adapted from Wang and Pies (2004) approach for child health assessment in community participatory research. Photography assists students who have poor written literacy, and allow for rapport to be built between the researcher and participants. Moreover, children are able to analyze the meaning of an image produced by them, bringing up the themes that they see as important. In this manner, they become active participants in research, without the spatial and temporal limits of traditional methods (Collier, Collier, and Hall 1986; Barker and Weller 2003). Participant observation was complimentary to results from in-depth interviews conducted with women in each of the BFP participating households. These interviews were conducted once or twice in each household with the goal of understanding the dynamics of household money management, specifically the BFP-benefit (a detailed description of the interviews is included in Chapter 3). A census survey was also used as a method for demographic data collection, as outlined in Chapter 2.

Table 1. Overview of methods and samples.

Methods	**Primary sample**			**Secondary sample**
	Adult mothers (in BFP)	*Female adolescents*	*Male adolescents*	*Adult mothers (not in BFP)*
Census	43	NA	NA	25
Photovoice [a]	NA	27 in total		NA
Money- management interviews	34	NA	NA	NA
24-hour dietary recalls [b]	18	10	15	0
Anthropometry [b]	39	12	15	NA
24-hour food frequency questionnaires	NA	NA	NA	25
Parasitic infection data (fecal stools)	35	11	8	NA

[a] Number of adolescents participating in photovoice meetings varied greatly (see the Appendix for details); [b] Repeated 6 times throughout the year (twice in each season).

Combined with participant observation, various methods were used for assessing the local food culture, as well as to evaluate nutrition and health status. The methods used were 24-hour recalls with additional data on sources of food (produced by the household, purchased, or donated from other households), anthropometry (height, weight, and skinfolds), and analysis of fecal stools to determine the presence of parasitic infections. The first two methods outlined above are described in Chapter 2, and anthropometric data collection is explained in detail in Chapter 5. Most of the dietary data used here comes from 24-hours recalls, chosen to estimate food intake, even though the literature highlights the difficulty in collection and problems with accuracy and validity (Burrows, Martin, and Collins 2010). Nevertheless, studies show that 24-hour recalls are improved when administered repeatedly and when clear instructions are given to participants prior to data collection (Carroll et al. 2012). Moreover, the Brazilian national survey on household consumption uses repeated 24-hour recalls, which was tested against the gold standard measure of 'doubly labeled water', concluding that intake was underestimated by about 15% (IBGE 2010).

DISSERTATION ROADMAP

Chapter 1, "Everyday life at Amanã" sets the stage for the reader to picture the routines of residents living at the Amanã Reserve, and the feeling of being surrounded by water. I address my personal experience as an outsider in these communities, associated with the Mamirauá Institute for Sustainable Development (IDSM), and with their legacy in environmental and community development. I also bring the perspective of adolescents to the forefront, using accounts prepared by them, to situate the reader about adolescents' participation in productive activities, household duties, as well as their aspirations and enjoyments. In addition, I also reflect on the positions of women living at Amanã, particularly focusing the discussion on issues of violence, prejudice, and empowerment.

Chapter 2, "Everyday food culture and the environment at Amanã", invites the reader into an in-depth analysis of diets of adult women and adolescents in the Amanã context, taking into account seasonal fluctuations in the availability of resources commonly used in diets, such as *farinha* (manioc flour) and fish. Dietary results are then integrated in the accounts of experiences of mothers, girls, and boys, and further analyzed in light of results from the analysis of parasitic infections. While *farinha* continues to be the major source of energy, and fish is certainly the most important source of protein in diets overall, the diets of adolescents, compared to adult women, have a higher energy contribution from vegetable oils and highly industrialized foods. Moreover, relative to male adolescents, the nutrition of female adolescents presents a picture of higher industrialized foods, higher rates of intestinal infections from multiple parasites, as well as diets not meeting daily energy requirements. The health status of mothers and adolescents is further analyzed in Chapter 5.

Chapter 3, "Bolsa Família and food, what are people buying and how are they making decisions?" describes money management in the households studied, from the perspective of women. It discusses if the BFP benefit is separated as a special purpose money, also showing how the benefit is spent and the reasoning behind this expenditure, again based on women's accounts. In this chapter I show evidence of how heterogeneous households are, both in terms of income level, and types of money management. Results show how the BFP benefit is predominantly seen and used as a special purpose money in the households studied, sometimes reasoned as a money to help the family, or children in the household, or a money which should be controlled by women. The recognition that the BFP benefit carried a special meaning was important in management, even if differences in income level also play a role in types of management and expenditure.

Chapter 4, “The Bolsa Família in light of the nutrition transition” introduces the secondary sample of women living in households which do not participate in the BFP, but are located in Amanã. Comparing food items in diets of women in BFP-participating and non-participating households, findings indicate that women participating in the BFP consume a higher proportion of ingredients such as vegetable oil or sugar in their diets, but as part of recipes in which locally sources foods are the core ingredients, such as fried bananas or manioc cake. This characterizes a change in diets, but not necessarily a shift, as women participating in the BFP were consuming local staples, fish and farinha, with the same frequency as non-participants. In addition, women participating in the BFP seem to be consuming food items produced by the household more frequently than non-participants, including bananas, açaí fruit, and watermelons. The data suggests that the inclusion of ultra-processed foods in diets (e.g. breads, candies, and canned meats) may be more related to age, with younger women consuming a higher proportion of these items in their diets.

Chapter 5, “Consequences of the Bolsa Família to physical status and nutrition” brings together key results from previous chapters with the following goals: presenting a picture of the health status of women and adolescents living at Amanã; analyzing the relationship between BFP management in the household with outcomes in nutrition and health; and contextualizing this relationship in the Amanã Reserve scenario. Findings show that women’s control over the BFP benefit, compared to a joint control, may not translate into an improved health status for these women and their adolescent children. I suggest differential consequences in the short and long term. In the former, adult women controlling BFP funds are at a higher risk of obesity and diseases associated with it, in a context where access to health services and treatment are precarious, and obesity rates among women are increasing. For adolescent males and females, the increase in BMI associated with mother's control of the BFP in the household is beneficial, due to more securely available energy during adolescence, a demanding period of growth and development. In the later, taking a long-term perspective, adolescent females may be at a higher risk than males of having the double burden of malnutrition and obesity.

Finally, in the conclusion, I refer back to global trends in this dissertation's framing, concerning CCTs as a strategy to improve nutrition and health in poor household, as well as the nutrition transition, as a shift from diets in which non-industrially processed foods are predominant, to diets in which industrially processed foods comprise the majority of the energy. The results from each of the chapters outlined above are instrumental to understanding how these trends play out for women and adolescents living in Amanã. For instance, results from Amanã, compared to other areas of the rural Amazon, indicate that historical and environmental factors mediate and hinder the effects of the nutrition transition there. These factors are related to the upland forest landscape, history of conservation-related activism, and participatory management of natural resources in the formation of the Amanã Sustainable Development Reserve. Residents' identities in relation to their communities, family ties, and the landscape are also clearly important.

CHAPTER 1: EVERYDAY LIFE AT AMANÃ

The fluctuation of the river waters is one of the most dramatic changes experienced by someone living in the Middle Solimões region, where Amanã is located. The gradual intrusion of waters in communities, houses, and production areas shapes social and labor relations. When the water is at its climax children may enjoy jumping into the river right from the front door of their houses, fisherman change their strategies for catching fish, and women and adolescent girls may access river water for domestic use more easily. However, the flooding of houses and production fields brings an urgency of harvesting or even moving away to the whole family. The grand scale of this change in river flow has bearing in transformations at various levels of depth, from individual behaviors and family relations in the household, to the organization of entire communities and towns. My memory of first arrival in the Middle Solimões region in 2012 assures me that any newcomer in Amanã is astonished by the landscape transformations brought by river fluctuations. While living there in 2014 and 2015, every day I would wonder if in that snapshot of time the waters were expanding or shrinking. I could never tell. Some locals would assure me of one or the other, but I could never figure it out.

The goal of this chapter is to describe everyday life in Amanã from the ethnographer's point of view. I also use an emic perspective, mostly of female leaders in the community with whom I developed a close relationship, as well as adolescents who participated in Photovoice project activities (method detailed in the "Appendix: Photovoice methods" section). Appendix 1 has all additional photovoices not included throughout the dissertation. To ensure the confidentiality of the data, I used pseudonyms for community names, as well as for participant's names, throughout the dissertation. I start with a brief history of the creation of the Amanã Reserve and occupation of the Middle Solimões area. I then address my positionality and the many identities negotiated by residents, particularly women, in various aspects of their social lives, such as the church, the soccer field, as well as in many of the actions of the Mamirauá Institute for Sustainable Development (IDSM), with which I worked during my fieldwork. Within this context, I convey how environmental changes are intertwined with the social landscape, as well as the importance of identity negotiation in the organization of life in Amanã.

INTRODUCTION AND THE PHOTOVOICE PROJECT

The Photovoice project offers a window into the everyday lives of adolescents, and results are presented throughout this chapter. During the Photovoice project, adolescents had the opportunity to take photographs around the community and write narratives, thus providing an emic perspective on issues they felt were important to them. The Photovoice project was instrumental for me to build rapport with adolescents while enriching my understanding of the activities in which they were active participants. The Photovoice narratives and photographs provided an entry point to discuss adolescents' views on their routines, including activities and interpretations I would otherwise not have access to. This is the case mainly because the Photovoice required adolescents to reflect on the reasons for taking a picture, and to develop ideas through time and in collaboration with others.

The Photovoice culminated in two local exhibits, one in the largest community participating in this research, referred to here as Santo Agostinho, and another at the IDSM headquarters (Figure 3). The exhibit was organized with the assistance of the adolescents who participated in the project. Two of them presented their views on the project during the opening of the exhibit at the IDSM. For the exhibit, photographs were organized as they fit into the landscape of rivers, lakes, fields, forest lots, and homes in the communities, with the soccer field in the center. Various types of photograph stands were made by the women in the same fashion as their basketry weaving. The photo stands were hooked to the ceiling using fishing line and the narratives were then attached to the line. Sinkers were placed near photographs and printed narratives, creating a balanced weight to allow for stands to move upward and downward, mimicking the water level during the flooded and dry seasons. Across the board, parents valued the participation of their children in this project. Many adults in the communities attended the exhibit, congratulated their children and myself for our work, and seemed proud of the results.

Figure 3. Photovoice exhibit at the Mamirauá Institute for Sustainable Development (IDSM).

THE FORMATION OF THE AMANÃ RESERVE

The Amanã Sustainable Development Reserve was created as such in 1998 and is now overseen by the State Center for Conservation Units (CEUC) and the IDSM. A Sustainable Development Reserve (RDS) is a category within the Brazilian National System for protected areas described as “a natural area inhabited by traditional peoples, whose life is based on sustainable use of natural resources, developed through generations and adapted to the local ecological conditions, performing the fundamental role of nature protection and maintenance of biological diversity”(SNUC 2000).

There was a complex political scenario and history for the creation of protected areas in which traditional populations were viewed as essential for the management and conservation of natural resources in Brazil. Researchers and grassroots movements, nationally and internationally, were involved in the successful outcomes. One important element in this scenario was the influence of the Liberation Theology movement of the Catholic Church starting in the 1950s and 60s, organizing Base Ecclesial Communities (CEB) in the Amazon, introducing social ideas and democratic methods for addressing community needs (Pace 1992). This was the case for residents of Amanã who still had vivid and memorable accounts of priests who trained political leaders and assisted in various projects of community development, such as building a well to provide safe drinking water to residents. Moreover, Alencar (2009) documented how communities were settled in strategic locations in order to have control over resources important to them.

The first protected area created under the category of RDS was the RDS Mamirauá, neighbor to Amanã. In the case of Mamirauá, the creation of a protected area culminated from multiple efforts from researchers invested in the conservation of the native fauna and flora, most notably the biologist José Márcio Ayres (Alves 2011). The initial flagship for persuading the government in creating a protected area along the floodplains of the confluence between the Japurá and Solimões River was the presence of an emblematic primate species of *Uacari-branco*

(*Cacajao calvus calvus*), endemic to the region, and then threatened to become extinct. In 1986, the Mamirauá Ecological Station (Estação Ecológica Mamirauá) was created as a direct result of a petition crafted by Márcio Ayres and Luis Cláudio Marigo. However, this category of protected area did not allow for the residency and use of the natural resources by traditional populations in the area (Queiroz 2005).

In 1996, with the conviction that participation of the local population was crucial for natural resource monitoring and conservation, researchers were successful in their efforts to influence policy, and the RDS category was created. It was first designated exclusively for the Mamirauá Reserve, and later incorporated into the national system of protected areas. The RDS Amanã was created in 1998 following a model of sustainable development as a successful example of community development and natural resource conservation. The Mamirauá Reserve covers an area of 1,124 thousand hectares (approximately 2.8 million acres) mostly of seasonally flooded areas, while the Amanã Reserve covers an even larger area of 2,213 thousand hectares (approximately 5.5 million acres) of both upland and seasonally flooded areas influenced by the Solimões and Negro River Basins. The creation of the Amanã Reserve allowed for the establishment of the largest ecological corridor of formally protected tropical forest (Figure 4), linking the Mamirauá RDS with Jaú National Park (Queiroz 2005).

Figure 4. Amanã RDS located in the Middle Solimões, surrounded by other protected areas.

HISTORY OF OCCUPATION

Explorers in the 17th century documented Amanã as an important area for exchange of goods among various indigenous groups. Gomes, Santos, and Costa (2014) summarize important accounts of the great cultural diversity and various ethnic groups who have historically occupied the area. Colonization was marked by the disappearance of indigenous groups (e.g. Yuri), runaways from violence and slavery (extensively documented among the Miranha, including children, in the 19th and 20th century), as well as alliances, and pursuit of commercial ties with the Portuguese, including the dissident Muras (Gomes, Santos, and Costa 2014).

Historically, diverse extractivist products were important during the colonization of the Amazon and permeated social and commercial relations. These forest products included Brazil nut, *sorva*, *andiroba*, *copaiba*, and others. The second half of the 19th century and the first decades of the 20th century were marked by the extractivist economy. The economy of rubber tapping started in 1850, initially with a local supply of labor, soon followed by large migrations from the Brazilian Northeast to the Amazon region. This migration accounted for a six-fold growth in the Amazonian population between 1850 and 1910, commonly referred to as the rubber boom period (Pinton and Emperaire 2000).

The rubber economy was directly influenced by national policies for migration from other Brazilian regions, especially from the Northeast, a region of the country with extreme poverty and a predominantly dry climate. Upon arrival, these migrants were subject to similar conditions as those suffered by the indigenous population, in a system called *aviamento* (Gomes, Santos, and Costa 2014). In this system, trading was marked by an indirect connection with the market, restricted to personalized relationships with a buyer of particular products (Léna and De Oliveira 1991). The aviamento system has been characterized as rigid and abusive, one in which workers were exploited by owners of vast land holdings (*patrões*) and on whom they were dependent for on almost all resources (Franca 2009). Rubber trees (*Hevea brasiliensis*) are scattered throughout the landscape, and rubber tappers were forced to work in remote areas inside the forest. In this context, men commonly left their families behind for long periods of time, establishing a pattern of dispersed families (Alencar 2009).

In 1910, Brazilian rubber became too expensive in the international market, unable to compete with cheaper rubber produced in Malaysian plantations. During World War II, there was a period of revival in Brazilian rubber production, when the Japanese blocked the provision of rubber from Malaysia to North America. Production was briefly reestablished and rubber tappers later gained the sobriquet of rubber soldiers (Franca 2009). With the decline of the rubber system, many patrões lost or abandoned their lands. Rubber tappers experienced an outbreak of hunger, deprivation, and migrated in large numbers to urban centers.

Inequalities in the Amazon were reinforced by this transformation since the elites owned valuable resources while the majority of the population was marginalized. The decline of the rubber system left an empty economic and political space in which novel proposals for development were possible, a favorable regional scenario for a gradual and inflamed struggle for the creation of protected areas with the participation of traditional populations (Schmink and Cordeiro 2008).

AGRICULTURE, FISHING, AND IDENTITY AT AMANÃ

This research was conducted in communities located in the Middle Solimões, a white-water river system, in tributaries of the Japurá inside the Amanã Sustainable Development Reserve (Figure 4). These are highly fertile areas compared to adjacent black water systems, where sediments carried from the Andes are deposited downstream during the rainy season (Moran 1993). In the areas studied there are also a series of black water lakes, frequently used for fishing, and a mix of upland and seasonally flooded land.

The Amanã RDS comprises 2,213 thousand hectares of upland and floodplain forests, with annual water level fluctuations of 9 to 10 meters on average. It has a population of 3,860 ("Instituto Mamirauá - Conservação Na Amazônia - Amanã" 2015) distributed in 80 villages or localities (three or less households settlement). Agriculture, especially manioc production, is among the most important activities for people living in the Amanã RDS, given that most settlements are located in upland areas less affected by flooding compared to neighboring regions. Fishing for consumption and sale is also prevalent, and social benefits represent a significant portion of household income (Peralta and Lima 2014).

In comparison to its neighbors, in the Mamirauá RDS, Amanã residents have a reputation of being agriculturalists, mostly due to a great portion of the land in Amanã which is not flooded. Agriculture practices are also a product of the historical process of occupation and the decline of extractivist economies of rubber and other products (Alencar 2009), as mentioned earlier in this chapter. Indeed, livelihoods in Amanã are heavily based on agriculture, especially the production of manioc flour for consumption and trade. Comprehensive studies of agricultural practices in the region have shown complex patterns of slash and burn, shifting cultivation, and fallow periods of 2 years or more (Viana, Steward, and Richers 2016), indicating a long-term benefit to agrobiodiversity and soil fertility in the context of the Amanã Reserve (Rognant and Steward 2015).

Manioc varieties and cultivation are central to livelihoods in Amanã, and have been identified in the literature as symbols of reproduction, subsistence, and resistance for many rural Amazonian residents. The production activities of Amanã residents are based on family relationships, aimed at subsistence and cash-income from agriculture, fishing and timber (Lima 2005; Peralta and Alencar 2009). Manioc flour, as a product for subsistence and exchange, has been key to the historical development of the Amazon (Pinton and Emperaire 2000) and women's participation, from the planting to manioc roots processing, is widespread (Murphy and Murphy 2013), including along the Middle Solimões (Peralta and Alencar 2009).

At Amanã it is commonplace for girls and boys to assist in the production and processing of manioc. In Joseane's account below, she recognizes that pulling out the tubers requires intense physical work. From my observations, this job was done exclusively by men. Joseane's account illustrates how the production of manioc, including the process of making it into flour and other products, is an activity involving the whole family, and frequently relatives from other households (Figure 5). The same pattern is observed from accounts of other adolescents such as in the narratives of harvesting bananas and watermelons presented later in this section.

> *"I woke up early in my grandma's house, went home, ate breakfast and went to the manioc fields. Then my mom told me to cut the uprooted cassava roots. I thought it was good because it was better than pulling them from the ground, which is harder. I was cutting the cassava in each root. I picked up a root, cut one, then another, and in the third I cut my finger. I cried, and almost passed out from pain. Later at home I said: I will never touch this machete again. I cut myself several times with it; this big stab and later the same day, my mother also cut herself*." (Joseane's narrative for "The criminal machete" photovoice)

Figure 5. Joseane's photovoice: "The criminal machete."

Manioc is a symbol of reproduction because of the cultivar's ties to gifts and exchange, remembrance of families' life histories, and support for newly formed households (Lima and Pozzobon 2005). For rural Amazonians, especially women, plants and seeds are embedded in the social and cultural contexts of households and often carry stories of origin and function from the point of view of the individual (Murrieta and WinklerPrins 2003), accompanied by an emotional attachment to certain plants, as well as direct references to memory and identity imprinted in the agrobiodiversity of spaces (Eloy and Emperaire 2011).

At the same time, manioc varieties are a symbol of subsistence given that even in the face of prejudice, manioc flour consumption historically persists in the diets of rural and urban Amazonian residents. Many authors have argued that besides contributing with large amounts of kilocalories, manioc flour is highly appreciated in meals and snacks as an "acquired taste," resulting from the historical relationships between the social and ecological environment (e.g. Murrieta 2001; Adams 2002; Adams et al. 2009). Murrieta (2001) makes an analysis of the historical and cultural meanings of manioc flour consumption and class in the Amazon, in which daily consumption of manioc flour in large quantities is seen as "inferior, derogatory, and undesirable" in the dominant imaginaries (Murrieta, 2001:56). Rural residents are still largely viewed by the urban elite as ignorant because they practice manioc cultivation, considered an ineffective, time and effort-consuming occupation, which provides little return or profit.

Along the lines of the persistence of cultivation, James C. Scott puts forth a thought-provoking argument about manioc as a cultivar of resistance, rooted in the agronomic characteristics of the plant: the tuber can be harvested gradually and is left safely underground for over 12 months even after becoming ripe. Compared to crops such as wheat and corn, state monitoring of harvests would require extended oversight, not worth the efforts of a tax collector. Moreover, the tuber is not susceptible to rapid destruction as a state penalty, for example, and would survive intentional burning, which is different from grains (Scott 2009). From this point of view manioc cultivation is seen as a rather successful strategy for resistance and subsistence, especially for populations living in remote areas with hardly any access to quality public services.

Samia’s photovoice below reveals many of the characteristics of manioc production outlined above. Her first line is poetic in the sense that it emphasizes the significance of an ordinary daily food, *farinha*, reflecting the idea of an “acquired taste,” as argued in Murrieta (2001). Samia then delves into what she calls the “mysteries” of the manioc tuber, exposing its importance as a safety resource for subsistence and trade. This could be argued as a form of resistance, as put forth by Scott (2009). This is also the case when Samia shows the possibility of adding variety to diets from the many products based in manioc processing, as well as characteristics surrounding storage, in the form of *farinha*, when harvest proves necessary (Figure 6).

> *“Farinha is important because it’s common. It comes from manioc, which has a lot of mystery, because from it many types of food are made, like batter cake and the starch [goma]. From the starch we still make tucupi [sauce] and beiju [manioc bread]. Besides being served as food, we also sell it, which allows each one to provide for their family. There are days when farinha is very difficult because when the water level is high, it destroys the fields. Ours never got completely flooded, only parts. When this happens we take advantage and pull out the roots.”* (Samia’s narrative for “The story about farinha” photovoice).

Figure 6. Samia’s photovoice: “The story about farinha.”

From the eyes of a researcher, residents of Amanã would easily fit into the academic descriptions of *caboclos* or *ribeirinhos*, problematized in the literature but referred to widely as a heterogeneous mixed population, and thus a product of the historical events of colonialism (e.g. Lima 1999; Guzmán 2009; Nugent and Harris 2004) . At Amanã, the term caboclo is not recognized as an identity, unless when used as a "joke" and usually in self-reference. The term ribeirinho is also disregarded, perhaps because of the collective nature and awkwardness it connotes, as explained by Lima (1999), since it refers to a homogeneous appellation not recognized by individual groups.

The term caboclo refers to a complex social category identifying racial, class and geographical attributes. Lima (1999) argues for two uses of the term, one conceptual and the other relational. The conceptual is used in the literature and other media as an analytical category for a diverse group of small rural producers with extensive local knowledge and similar dietary and housing patterns. The relational is used in ordinary day to day interactions, and is multifaceted, with a non-explicit relational nature among the interlocutors. The predominant stereotype associated with the term is historically pejorative, linked to an inferior social position. At the regional level, the meanings of the term have undergone transformations, as it becomes a useful category for political representation (Brondízio 2008).

The notions of identity for populations in the Middle Solimões have been identified collectively mostly in terms of familial ties, religion, history of occupation, and so on (Lima 1999). The regional identities discussed by Lima (1999) ranges from the ecology of the place, residents of floodplains are called *vargeiros*, while in upland areas people may identify themselves as *terra firmeiros*. Another common autonym is in terms of economic trade, where the *patrão*, the person who sells goods, is in a more favorable position, and the *freguês* may serve in an exploitative relationship. Indeed, people in Amanã would identify themselves in different ways depending on the context, commonly using their occupation as a reference--agriculturalist, fisherman, and teacher--or recurrently as *comunitários* (community members).

As outlined in the previous section, the identity of a comunitário is tied to the influence of the Catholic Church, and more recently to the actions of the IDSM. Between the 1960s and 1970s, the Catholic Church had great influence in the political organization of the territory, forming a social organization and engagement of rural residents under the premises of the "Movement of Grassroots Education" (Alencar 2009). Such developments were also the background foundation for the movement to protect fishing lakes in the Middle Solimões, in which comunitários would identify lakes and restrict fishing for commercial purposes, particularly commercial fishing boats and trespassers from outside communities. Until nowadays, founders of communities are usually referred to as "owners of the saint" or "patron saint" of a place (Lima, 2002: 148).

Throughout this dissertation I opted for using the term comunitários when referring to research participants, given that it was the most commonly used autonym which I observed in Amanã. Although the term is historically linked to liberation theology and the influence of the Catholic Church in the social organization, the term is frequently used in reference to collective rights or ownership. Many community and boat names nowadays reflect various religious affiliations (including for Adventists, Pentecostals, and others) and familial ties. Moreover, people always identified their residency by the term community, as observed in many of the photovoices produced by the adolescents included here and in other chapters of this dissertation.

Most of the finalized photovoices produced by adolescents participating in this research mentioned daily activities performed in groups, either with other family members, or with friends and relatives. Two of them explicitly talked about communal work (Simone's "Our soccer field" photovoice) or communally owned equipment (Sérgio's "Making farinha" photovoice). These themes will be further developed in the section on women's activities and engagement with governmental organizations and NGOs. Again, addressing the theme of manioc production, Sérgio's account shows how he helped his brother and father after arriving from school. He mentions that the community has joint ownership of manioc grinding motors, but how he wasn't able to make use of one this time.

> *"When I took this photo, my brother, dad, and I were in the casa de farinha* [structure where manioc is processed into flour and other products]*. My dad was sifting* [the flour]*, already at the end* [of the process]*, to take out the fiapos* [larger string like remaining pieces]*, and I took advantage of this little free time. When I got there* [to the casa de farinha]*, they were already peeling the tubers, and I went on to help. So we carried them to land* [referring to taking the tubers from where they were soaking in a nearby stream] *and went on to squeeze them. We didn't take the motor to grind the manioc after it's been squeezed, so I had to sieve it instead. The community has three motors to grind manioc, but I think only one is working well, and someone had already taken it. It would have been much better if we had the motor, because it would go way faster.* (Sérgio's narrative for "Making farinha" photovoice).

Figure 7. Sérgio's photovoice: "Making farinha."

Manioc fields are certainly a central theme in the productive activities of most households involved in this research. There were, however, many other foods produced at a smaller scale, both for subsistence and for trade, particularly bananas, but also other fruits such as pineapples and watermelons. Below is a selection of photovoices from adolescents describing their participation in these activities:

> *"This day we went to harvest bananas. Me, my aunt, my cousins, grandma, my other aunt and my sister went. All of us carried bananas. It was my aunt's fields, in the middle of the Lontra banana fields, behind the community. It is really far, you have to pass the manioc fields of three people, and still need to walk for a bit more. It takes long to get there. The banana bunches were giant, really really large. There was banana* comprida *and banana* maçã [banana varieties]. *The tough part was to carry it back to the community, but we also got something out of it. We got sweet manioc and bananas that day, but I only wanted to keep the bananas." (*Sandro's narrative for "Banana fields" photovoice)

Figure 8. Sandro's photovoice: "Banana fields."

> *"The watermelon is a fruit that we eat a lot in our community. One Sunday I went with my mom and Dorilson to harvest some watermelon. The day was beautiful, but the heat from the sun was deadly. I went with a little shirt and got completely sun burnt, and later it hurt a lot. After five days, it [her skin] started to peel off where the sun had reached. It was a lot of suffering, but it was worthwhile because we got a lot of watermelon, we sold and ate a bunch!"* (Alaíde's narrative for "The watermelon" photovoice)

Figure 9. Alaíde's photovoice: "The watermelon."

Indeed, Alaíde was correct in stating that watermelon is highly appreciated in the communities studied. In Chapter 2, I describe the food culture, also in terms of macronutrient intake. Compared to all other fruits, watermelon provided the highest amount of kilocalories in diets, surprisingly surpassing açaí, which was also high.

Fishing and hunting were also present in the daily lives of adolescents, especially boys, as illustrated in the photovoices below produced by Gerson:

> *"One afternoon I went to check the tambaqui [type of fish] gill net with my friend. It'd been a few days I hadn't checked it, and we went to get it out. Once there, I saw something white and more closely we were able to spot an alligator. The net wasn't worth anything anymore; it was all holes. What mattered to me was the alligator was dead. Every year he would eat fish out of our net. My dad was surprised because a 5-meter alligator is very strong and that one used to pick on gill nets."* (Gerson's narrative for "Alligator in gill net" photovoice)

Figure 10. Gerson's photovoice: "Alligator in gill net."

> *"When it turned 5:30 pm I thought: I'm leaving because it won't come today [referring to a spotted paca]. But a thought of staying until 6 came to mind, and so I stayed. At 5:45 it arrived, all very agile, dug the manioc and was eating without seeing me. I wasn't seeing it very well, but I knew its direction. It was then that I shot and ran over there. It was wounded. I went to grab her feet and she wanted to run, so I had to hit it with the shotgun for it to die. My dad thought I hadn't caught anything, besides the ticuam* [type of bird] *was singing. He* [his father] *had gone out fishing.* (Gerson's narrative for "Waiting in the fields" photovoice)

Figure 11. Gerson's photovoice: "Waiting in the fields. "

Moreover, in terms of income -generating activities, wage jobs were substantial, most notably for women as teachers and janitors at local schools. These were examined in detail in Chapter 3.

Older adults in the communities studied would tell me that in their childhood it would take days and many paddling arms to get to the nearest town in a small canoe. While I was there it would take about 15 hours or so, by boat or in small motorized canoes, adding or subtracting a few hours depending on the water levels of the river. Darlei's photovoice (Figure 12) illustrates his view on the importance of the motors that residents attach to the canoes nowadays. Darlei's account shows how the importance of transportation is not restricted to having access to services in town, perhaps particularly from the point of view of adolescents. In the case of Amanã, residents also go to town to visit relatives, participate in social events, and attend school (some adults are pursuing their undergraduate degree and spending about a month in town to attend condensed courses). Ineida's photovoice (Figure 13) also addresses the issue of travelling to town, she describes the long travel, the process of cooking on the way, and her satisfaction in meeting her relatives living in town.

> *"The* rabeta [*small engines placed in the back of canoes*] *is very useful for someone that works in agriculture here in the community. The rabeta serves to transport crops to where they are sold. It also serves to transport people who like parties and who like to watch soccer games, which are common on Sundays in other communities around here. One time, our rabeta from our house broke down and we stayed a long time paddling to work. That's why I tell you my friend: if you have a rabeta, take good care of it!"* (Darlei's narrative for "The value of a *rabeta*" photovoice)

Figure 12. Darlei's photovoice: "The value of a *rabeta*. "

> *"On this day we went with my mom and dad to town so they could vote. I wasn't going to go, but my mom wanted to take me. It took almost the whole day to get there, so we took a little stove to make food along the way. My mom got out the pot, a bit of water from the river, the tucunaré* [type of fish] *we brought, cooking oil, the green onion in this picture, salt and colorau* [seasoning]. *It tasted really yummy! I liked to go to town because I got to go to the* [sports] *court with my uncles and cousins from around there."* (Ineida's narrative for "The green onion" photovoice)

Figure 13. Ineida’s photovoice: “The green onion. “

Even in the context of populations living in the rural Amazon, the remoteness of this area is unique, as the Amanã RDS sits between two other large protected areas (Figure 4). Still, the connection with urban areas is relatively steady and more recurrent than in past decades. This mobility has been described in the literature, partly as prompting changes in desires and livelihoods, and conversely as promoting a reassurance of local knowledge and identities (Eloy, Brondizio, and Do Pateo 2015). Here I include isolation and connectivity in terms of physical distances and as a metaphor, referring to the relationships developed among community members considering the impact of important organizations influencing the social life of comunitários. In this sense, I discuss relations among people within one or nearby communities, especially considering the perspectives of women and adolescents about the school, church, and other organizations in which they are involved. The main sample of households in this research were located in three communities, referred here as Santo Agostinho, the largest one, Vila Central, and Nova Oeste.

POSITIONALITY AND OTHER IDENTITIES

The sole mode of transportation for the largest part of the population in the Middle Solimões is by boat and private small canoes. It can be argued that Amanã residents experience this isolation the most, given that they live in a remote area in the confluence of the Japurá and Solimões River inside a protected area. However, as outlined previously, the legacy of slavery, paternalism, church involvement, and RDS creation emerges in the everyday discourses, showing a great connection with the outside, throughout history as well as currently. Their identity is tied to the history of encounters with different groups, and they are aware, and developed strategies for negotiating with these different actors.

Deborah Lima (1999) identifies the importance of kinship and the sense of identity tied to a notion of insiders and outsiders in communities of the Middle Solimões area. Most of the organizations with which Amanã residents are in direct contact, have both insider and outsider representatives with various degrees of agency in decision making. Examples are the church, the local government (through the school, election, mayors' visits and community events), as well the Mamirauá Institute for Sustainable Development (IDSM) and NGOs such as Amazonas Sustainable Foundation (FAS) and Sebrae (Brazilian Micro and Small Business Support Service). In this section, I give my own account about the conflicts and affiliations in the everyday life of comunitários, assisted by the expression of adolescents through the narratives and photographs they produced in their photovoices. The following sections continue to describe comunitários' relationships with the church, and IDSM, focusing on women's experience and identities. I begin by positioning myself and my identities as a researcher in the Amanã social structure.

In the communities studied, I was, of course, viewed as an outsider. I arrived in the communities for the first time with staff from IDSM, and with members of the Catholic Church, accompanying IDSM staff, to conduct a workshop on medicinal plants. In addition, I arrived with my husband who was also proposing to conduct research in the same communities. My husband is American and speaks Portuguese *enrolado*, as they would say. Most of the communities studied had had contact with researchers from the Mamirauá Institute before, including people from the Middle Solimões region, Brazilians from other regions of the country (typically from the Southeast, like me), as well as non-nationals, mostly Americans, Germans, and French. My arrival indicated I was working with the IDSM, so it likely appeared I had similar purposes. One of the most noticeable values linked to the IDSM is environmental conservation and community development. At the same time, there is an unofficial and weaker link to the actions of the Catholic Church, a legacy from the history of the creation of the Reserve, as outlined in previous sections.

From that first encounter, residents started to perceive my position in the context of Amanã. Residents viewed me as a person of a higher social-economic means compared to them. Older men were direct about expressing this assertion and were constantly reminding me and other community members of my privileged position. They would point out the fact that I could come and go to the nearest town or urban areas farther away much more often than they could. They would also characterize my work as “having a good time chatting with people” or walking around without having to do much effort. Pedro, Dores husband, would greet me every evening with a variation of: “Are you still strolling around, Carolina?” I understood where Pedro and other men in the community were coming from. Many residents, especially older men and women, are part of a marginalized population who had little opportunity to develop any of their own social and professional aspirations; in fact, many endured oppression and struggled in order to have their basic rights recognized. I have some accounts of adult men and women, as well as adolescents, throughout this dissertation showing their long arduous hours of work inside and outside their households. I also heard of difficult moments in their lives, especially concerning illnesses and accidents in which residents received little assistance, from situations regarding snakebites and alligator attacks, to the drowning of children. Therefore, I understand resident's views of my privileged position and I agree with them. While I was sometimes bothered by frequent criticism, I also understood that acknowledging it demonstrated their genuineness, as well as mine. Here, it seems pertinent to include Diego's photovoice describing how uncomfortable *mutucas* (horse-fly) are. Although they bother everyone, Diego could see a bright side of having them around.

> *"When I took this photo there was just this one still mutuca, because the others were flying, perturbing us. They [people in the community] were burning the fields, and that's when mutucas appear in all houses. The bug is not cool. When we are asleep in the afternoon, its bite is repulsive, it itches for a long time. At least we kill a bunch, and feed them to the chickens."* (Diego's narrative for "Mutuca" photovoice)

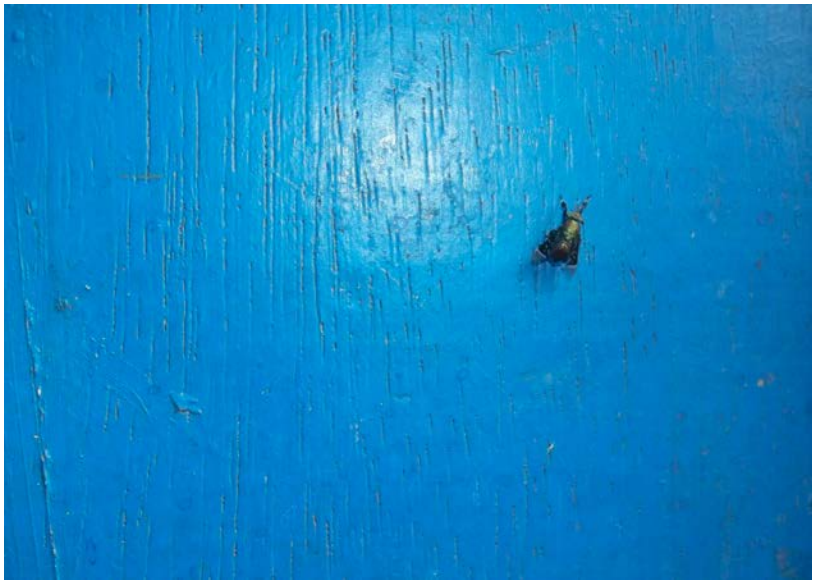


Figure 14. Diego's photovoice: "Mutuca."

I did recognize gender tensions in my interactions with adults in the communities. For instance, women would not direct criticisms about privileged positions at me, but some would gossip and tell me how other women indeed had the same view. As an adult woman, and with research focused on women and children, I naturally developed stronger relationships with adult women, girls, and boys. This is not to say that overall people were uncomfortable with my presence. On the contrary, I felt that most Amanã residents were very open to my research. After my first meeting with community members, they accepted and welcomed my presence, and many opened their homes for me to stay for long periods. The house of Dores and Pedro was one of the first ones in which I stayed for weeks. I am very grateful for that, and feel fortunate to have worked with a group of people that have this attitude towards a newcomer. In addition, I believe that the historical presence of the IDSM in the area was crucial for people to understand my academic research. Another important aspect is their familiarity with the university system, as some adults in these communities were taking undergraduate classes at a

State university in nearby towns. This was the case of Paloma, the oldest daughter of Dores and Pedro. Paloma lived in the nearest town for two to three months during the year, taking intensive courses, and returned to the community for the rest of the time.

Amanã residents pursuing their undergraduate degrees influenced the perception of other community residents of all ages. Paloma was pursuing her undergraduate degree in the same program as Valquiria, her neighbor. They once told me that they were really impressed by the amount of data I was collecting for my research, and wanted to follow my example. Later on, we talked about their final undergraduate projects and brainstormed some ideas. One day, after conducting a 24-hour recall with Dores, she proceeded to tell me that she thought my research was very important and that she would want to receive its results. Her recognition surprised me because I was not expecting her to be so clear and direct about the value of academic research, especially after participating in a 24-hour recall, a method of high respondent burden. However, this did make sense. Dores was diabetic and had to control her sugar intake, so that makes my research on food habits more relevant to her. I was unable to collect all dietary data with her because she had to travel to the state capital, Manaus, at least three times during my fieldwork in search for treatment.

The photovoices by Samuel, Dores' nephew, and by Nanda illustrate how adolescents viewed local teachers with admiration, and were encouraged to pursue an undergraduate degree. Samuel's brother, Sandro, was attending the university in the nearest town and worked as a teacher in a nearby community. Dito and Noemi, Nanda's parents, were both teachers at the school in Santo Agostinho. When they had to spend long periods of time in the nearest town to attend courses, they would commonly take Nanda, as well as Diego and Carina, Nanda's youngest siblings. Nanda's older brothers and sisters would stay in the community taking care of their household commerce and house animals.

> *"I asked my sister to take this photo when I was feeding my animals. This is a practice I learned from my grandmother. Every day at five o'clock is the time to feed them. I raise ducks, chickens, and a dog. In this photo I was taking care of my chicken that had chicks hatching from her eggs. This little house is only for the chickens to lay eggs and brood on them. On its side is where they sleep. I really like to raise animals. My biggest dream is one day to become a veterinarian so I can know more about these types of animals and others."* (Nanda's narrative for "My animals" photovoice)

Figure 15. Nanda's photovoice: "My animals."

> *"In this photo my mom is scraping stalk. She is an artisan and uses material she collects in the floodplain, which is the* cauaçu*. With it, she makes various objects such as jewelry boxes and photo frames. I also help her with the first part of craft making, which is to scrape the stalk. Then it's all up to her. She cleans and removes the insides of the stalk. I think it's great that she is an artisan because she sells crafts and makes good money. She helped my brother pay for college, which he could not afford alone. My dad also helped. Now my brother is a teacher. One day I also want to go to college."* (Samuel's narrative for "Craft making" photovoice)

Figure 16. Samuel's photovoice: "Handicrafts."

The fact that my research concerned a controversial federal policy also made some people suspicious, as a few women told me later on, including Dores. They were afraid I was sent by the government to monitor them and report any corrupt behavior. I am glad I was able to build rapport with many women and men in these communities in order to clarify my research goals, but I am afraid that with a few of them that was never possible. After all, they were correct about my privileged position and I had to respect their privacy and their right of non-participation in any activities they felt uncomfortable with. Because of that, I did apply the strategies of postponing interviews about the use of the Bolsa Família cash benefit to a later period of my fieldwork, as well as wait for participants to take the initiative of talking about it before I asked any direct questions regarding this issue. Moreover, I followed ethical procedures, as outlined by the Indiana University Institutional Review Board and the IDSM ethics committee, and a few participants did not agree to participate in certain research activities. In the next sections and chapters, I give more details about how interviews were conducted, as well as some of the challenges I faced.

THE PRESENCE OF THE CHURCH

The Catholic Church had great importance in the formation of the reserve and how it is organized. The division of the reserve in sectors is a legacy of the church organization maintained by the research institute and recognized by many residents. While the majority of the residents of the communities studied were Catholics, there was also a vocal and growing number of Seventh-Day Adventists and Assemblies of God. As mentioned previously, I first arrived in the communities with two IDSM staff members who were good friends with Dores and her sister Helena, mainly by attending Catholic Church-related events in the nearest town. I accompanied them with a nun who was giving a workshop on medicinal plants. The workshop was held in the community of Santo Agostinho during the weekend. Most women in the communities attended the workshop, independent of their religion. At the very end, however, there was a meeting held at the Catholic Church, to which less than 10 people attended: only women, two older adolescents, and myself. The nun played a religious song on a tiny speaker she brought and people sang along. Then she invited people to talk about the significance of the lyrics, which they did, but simply by repeating the words without any interesting interpretation or personal contributions. I later observed a very different pattern during Sunday gatherings at the Catholic Church located in Santo Agostinho.

Each Sunday an adult in the community would be responsible for reading and talking about a passage in the Bible, and adolescents would do that as a group from time to time. People expressed themselves in profound and intimate ways, many times crying and asking for support with issues and problems they were facing in their families, mostly related to physical and emotional health. Moreover, there were many personal interpretations of passages in the Bible, directly connected to their everyday lives. I participated in Sunday gatherings a handful of times and heard many interesting interpretations of passages in the Bible. For instance, with residents imputing that their neighbors should take good care of communal goods, such as the community boat, the motorized manioc grinder, as well as the central meeting building. Moreover, just before the election for president, the Sunday gathering was devoted to a reflection on the act of voting and Helena, who was the leader that day, interpreted a passage from the Bible as a message for people to vote with the interest of the whole community in mind.

I also attended an event organized by a Seventh-day Adventist minister and his wife in Santo Agostinho. The workshop went on for 15 days for about 2 hours every evening. I attended a few of the meetings in the first week, and heard accounts from many of the people who participated in all evenings. The event was organized so that the whole community was invited to participate. The minister and his wife brought a generator and a number of prizes, distributed every day after their lecture (the ultimate prize was a living room table, a type of furniture rarely seen in households in these communities). They conducted the event like a game show, replete with many videos and activities involving parents and children. Considering that there are no frequent social events in these communities, especially using this sort of technology, people were curious to watch, and attendance was high among Adventists and Catholics. Even older women and men intensely involved with the Catholic Church attended most of the meetings, but were skeptical and the event did not seem to have an impact on them in terms of changing their religious beliefs. In the very last day, after the ruffle of the main prize, they baptized residents who chose to convert. Although the whole village participated in many of these entertaining meetings, only two people decided they wanted to get baptized: a man and his daughter (his wife is Catholic and remained so; he apparently had already been baptized but decided to start over since he was not a rigorous practitioner).

Religion represented some tension within the communities studied especially because family members sometimes chose to follow different religions, and communal activities, such as the women's craft making group, or the association of fishermen, brought together people from diverse religious affiliations. Each community studied had a church. The Nova Oeste community was settled by Mercês and Josiel and their five daughters and three sons. Each of their children stayed and formed a household, some married residents of nearby communities and others married residents of the nearest towns. One of their daughters, Joelma, worked as the community health agent, hired by the municipality. Her parents and all her siblings were part of the Assembly of God, but she and Mariano, her husband, were Seventh-day Adventists (and highly involved in the organization of the event described in the previous paragraph). Joelma told me that during her childhood her parents were Seventh-day Adventists and were very rigorous about following their religious beliefs, as they were now as devotees of the Assembly of God. She strongly disapproved of their change of religion. Joelma and Mariano would always bring up religious issues during my interviews with them. For instance, when I approached them asking about what they considered as healthy foods they encouraged me to look for the minister in the nearby town, as he would be the one able to explain to me what the appropriate foods were. Joelma's sisters, however, would often make fun of her and Mariano when they were not around, saying that they would hide and eat certain restricted foods, given that they were so tasty and that they could not resist it.

I had less access to the Assembly of God church because, although Mercês and Josiel were always very respectful, they chose not to participate in my research. They were mostly concerned about me collecting fingernails which they believed were going to be used as witchcraft beyond my understanding. They did assure me that although I did not realize it, collecting fingernails was a sign of the Devil in his attempt to “mark” people (*marca do Diabo*). After that interaction, they still invited me to come to the community, and I continued visiting Nova Oeste. Among their daughters and sons, Joelma was the only one who also chose not to participate in the collection of fingernails or 24-hour dietary recall. I did not attend any Assembly of God events, but I did participate once in preparing manioc cakes in the house of Iracema, a daughter of Mercês and Josiel, to be served at an Assembly of God party at Nova Oeste.

WOMEN’S POSITIONS

Joelma and Mariano attended the Adventist church in the nearby town as well as in Vila Central, only a few minutes away by canoe and passable by land during the dry season. Vila Central is smaller than Santo Agostinho and Nova Oeste. I also became very close to some of the women living in Vila Central, but one family in that community did not accept participation in any of the activities of my research since my first attempt to approach them. This household was involved in many conflicts and members were fairly isolated from residents in the communities studied. Three women reported to me they had been sexually harassed by a man living in that household. One of them being Cristina, who also lived in Vila Central. Cristina told me that Tiago, her older son, was eager to fight with this man and that she was concerned about it because Tiago was very impulsive and also used to drink a lot. The situation was heated once while I was in the field, when Tiago punched this man in the face and was forced to flee from Vila Central for some time because of death threats.

One of the scariest nights I spent in Santo Agostinho was when I was living with Vania, an elderly lady, and Diana, her granddaughter. In the middle of the night, Conceição, Vania's daughter, sneaked in the back door right where I was sleeping in my hammock. Conceição was frightened and said that Marcos, her husband, was drunk and swore he was going to kill her. He was certain she was having an affair with Eliel, Vania's neighbor. Marcos was out of control and searching for the key to their back shed, where he had his hunting rifle; he seemed determined to shoot Conceição. Someone had hidden the key, most likely one of her children, and Conceição had been hiding from Marcos, moving from one house to another in the community. A little after Conceição left Vania's house, Marcos started banging on the front door, screaming that he was going to kill her. Vania was obviously upset and also shouted, remarking that it was absurd that he was coming into the house of an old lady at this time in the evening. She said there were only women in the house and he was not allowed in, but eventually opened the door. Marcos rushed inside, searching every corner for Conceição. At this point, the whole community was awake and aware of the situation. When Marcos left, people came to tell us that a number of men were holding him, so he would not break into the shed and retrieve the rifle. A few minutes later, Marcela, Conceição's daughter, storms into Vania's house desperately crying and repeating that her dad is going to burn down their house. At this point we see the flames a couple of houses away.

This episode completely changed my views on gender relations in Santo Agostinho and nearby communities. I became more alert and aware, and women did start sharing more of their experiences about household conflicts and gender relations with me. That night no house burned down (only a small section on the front porch of Conceição's and Marcos's house was damaged), and no one got hurt, but the whole community was in fear. Nobody in the community saw Marcos leaving his house for the next three days after that. When I asked him what had happened, he told me he did not remember anything. I think, and I hope, he was deeply ashamed. I would have a hard time believing those events had transpired had I not witnessed it myself. Marcos seemed to me to be a kind and respectful man. In fact, I worked with him throughout my fieldwork. I was doing the accounting for their household commerce in exchange for having data on the foods they were selling to the communities. Marcos and Conceição had the greatest assortment of goods to sell in that area, and people living in Santo Agostinho and nearby communities would stop there to buy food and other supplies that they needed before their next trip to town.

Understanding women's ideas and positions in the context of Amanã presented a great challenge for me, mostly because of the heterogeneity in socio-economic status and gender relations in the household. While I felt many women had autonomy over their actions and easily shared their views, others seemed suspicious or fearful. Although I recognize that this research touches upon a sensitive topic of household money management and decision making, including the management of a cash benefit transferred from the federal government; I also believe that given the evidence above, women were subject to violence and prejudice, and felt like their rights and aspirations were constrained by expectations from their husbands or other family members. In the following paragraphs, I touch on some of the evidence I encountered during my ethnographic fieldwork regarding women's position in these communities, also outlining women's accomplishments. The following chapters also address issues related to women's social position, whenever they assisted with the interpretation of results.

Within the communities studied I did observe women having leadership positions in many instances, especially the church and the school. There were sometimes clear gender divisions, and one could be seen in a central aspect of their leisure culture: soccer. It was essential for these communities to have a soccer field. In fact, the bulk of houses in Santo Agostinho were organized around the soccer field. Children, including boys and girls, would often be playing soccer around 4PM, before the main field was taken by men who would then own the space. Still, the field was large enough that children would often gather on the sides and continue to play. Just before sunset men of the winning team would gather in the middle of the field to share 4 or 6 liters of soda, the usual payoff from the soccer bet, purchased from Marcos and Conceição. Then, everyone would go jump in the river to wash off their muddy clothes and bodies. Sometimes a few players from Vila Central or Nova Oeste would stop by, but of course they had their own soccer fields in their communities and had a similar ritual which I witnessed when I was ever there in the late afternoon. It was common for me to have trouble to work on anything with any of the adolescents at this time of day, because soccer was so sacred to them.

During the first weeks I stayed in Santo Agostinho, women told me about their project to clear the way for their own soccer field. They opened up a semi-forested area in the back of the community and I ended up working alongside them a few times in their endeavor. This was a clear symbol of a gender division in that community, probably more so than in Vila Central and Nova Oeste. Adult women and older adolescents in Santo Agostinho had three organized teams with coaches, but played far less than the men, so they decided they needed their own soccer field. Elaine's photovoice, "Our soccer field," shows her perspective on the women's soccer field. Tournaments involving various communities inside Amanã were very common for men, and women would attend these events, but would rarely get to play. The women were not able to finish the job by the following June, as Elaine had wanted, so, again, they did not get to play their own tournament.

> *"In January of last year, the women got together to open an area for a soccer field, so we could play a tournament in June, but it was not ready in time. We worked a lot, but we were unable to uproot the stumps. Then the women paid two men to help. We have faith in God that this field will be ready before the festival this June. I like to play soccer a lot, because I get dirty, and at the end I get to jump in the water*." (Elaine's narrative for "Our soccer field" photovoice)

Figure 17. Elaine's photovoice: "Our soccer field."

Santo Agostinho was a central place for all the smaller communities around that area. It has the only secondary school in the area and a public phone powered by solar energy, which works intermittently, but is the only mode of communication for residents of all surrounding communities. There is also a local health center, which did not seem to be providing much assistance, as health agents were residents with minimal training. Health agents usually visited the houses but rarely used the facility itself (which was under construction most of the time I was there). The health center operated a speed boat provided by the municipality, which was frequently used to transport residents to the nearest town during emergencies. Because the health center boat had a powerful motor, it demanded large quantities of gasoline. Whenever the health agent needed to transport someone, gasoline was provided by the municipality upon arrival in town. To leave the community, however, he would have to count on borrowing gasoline from community members. Sandoval, an older adolescent who lived in Santo Agostinho and decided to join the photovoice activities, wrote an account about the health center (Figure 18).

> *"When the community started, the health center was a building made of wood, then it was built of masonry. There wasn't much inside it, but it helped. Now it's getting rebuilt and larger. I hope we get some medical care, because the community is growing and a health agent is not enough. We need to get better materials and medicines. Sometimes I get a lot of stomachaches, and if there was a doctor who could come visit, I wouldn't have to always go to town. The last time I got a speed boat it took 4 hours, having to pass even in the middle the tall grass. It's very difficult to travel when you're sick!"* (Sandoval's narrative for "The health center" photovoice)

Figure 18. Sandoval’s photovoice: “The health center.”

Santo Agostinho was also a stopping point for residents of communities around the area, not only because of the school, health center, and public phone, but also because of Conceição and Marcos small shop, and for having two communal structures, one large masonry gathering space people used for events, and another large wooden house built in partnership between the women’s group of craft making and a regional NGO, Amazonas Sustainable Foundation (FAS). The women’s group of craft making has strong political standing, with visibility at IDSM and with temporary business partnerships in Manaus, the capital of Amazonas state, as well as in other regions of the country. Two women, Nicéia and Leide, had travelled to capitals of other states in the Southeast of the country to participate in crafts markets, where they sold many of their wares. Their account about the history of the group was fascinating, and involved the participation of the IDSM and other NGOs such as the Brazilian Micro and Small Enterprises' Support Service (Sebrae) and FAS.

In Samuel's photovoice entitled "Handicrafts" (Figure 16), he clearly values the work his mother, Helena, does as a craftswoman. Helena is highly involved in the women's group and her sister, Dores, was the president of the group during the time I was in the field. Helena also told me that in the past, her son Sandro wanted to join the group, and that she supported him, but that the other women voted against him participating, since he is a man. This is again an example of how gender relations played out, and Sandro was not able to make his way into a lucrative activity practiced by women in the area. This pattern may be rooted in the history this group and the difficulties women in Santo Agostinho and other communities faced during the process of forming the group. At first, their husbands did not agree with the idea that they would be travelling alone to other communities to attend meetings. Moreover, few women felt comfortable travelling now to distant places to sell products and this seemed to lead to disputes in many households. According to Nicéia and Leide, they were the only ones who had travelled to business fairs outside the state because none of the other husbands agreed that their wives should be allowed to travel alone.

Women in all the communities studied seemed to be gradually gaining agency in many aspects of the social life at Amanã, and in each household gender tensions and agreements developed in different directions. Women's social position in these communities was highly variable, and heterogeneity was reflected in their occupations, productive activities, as well as in decision making around money management in the household, a subject that is central to Chapter 3 of this dissertation. In this section I showed some of the annoyances and even harassments women are subject to in the context of Amanã, but also some examples of their positions in important community organizations, such as the school and the craft making enterprise, all of which are directly related to household income. Their initiatives are also present in other key social activities in the communities, such as playing soccer and planning school and church festivities.

IDSM PRESENCE

The history of creation of the Mamirauá Institute for Sustainable Development in 1999 is intrinsically related to the conservation of natural resources in the Middle Solimões area, as well as with community participatory management, as outlined in the previous section entitled "The formation of the Amanã Reserve." While the contribution to scientific research and community development supported by the IDSM at the RDS Mamirauá and Amanã is undeniable; as expected, residents expressed both satisfaction and frustration regarding the diverse actions of the IDSM in their communities. Using ethnographic accounts, here I describe my impressions about the IDSM presence in Santo Agostinho, Vila Central, Nova Oeste and a few localities near these communities.

It is important to note that I received financial and logistic support from the IDSM and people in the communities were aware of that and viewed me as part of the IDSM research team. However, after spending long periods of time in these communities building rapport, I came to understand three main disagreements towards the actions of the Institute. First, some comunitários viewed the institute as more focused on conservation of natural resources than on residents' quality of life. This pattern reflected a view of community development and safety as contrary to environmental conservation, which stands in opposition to the intellectual foundations of the IDSM. One classic example is the views around conservation of alligator or snake species. Overwhelmingly, residents saw these species as dangerous and a threat to humans and knew relatives who had suffered or died from alligator attacks or snake bites. Secondly, a few people also expected more assistance from the IDSM, for instance with finding business partners for the products originated from their productive activities. Finally, some groups disliked that the Institute would commonly build projects around community development, instead of focusing on individual projects.

In general, comunitários who approved most of the actions of the IDSM gravitated towards contributing to the research activities I proposed because of my association with IDSM. I was introduced by IDSM staff to the communities, and most of the times I left or arrived in the community, I was picked up from or taken to an IDSM floating base, about an hour away from Santo Agostinho. Gender relations also played out in this case, given that women were highly involved in projects supported by the IDSM, such as the crafts making group. By no means, however, the actions of the IDSM were restricted to women's activities. One of the main research fronts of the IDSM was related to the management of fisheries, and, in the case of the communities studied, men were the ones directly involved. While there were few men who identified themselves as fishermen in the communities, one exception was the harpooning of pirarucu (*Arapaima gigas*) during the legal fishing season in October, when most men left their households and camped for days in nearby lakes designated for fishing, generating an annual seasonal income.

Women and children stayed behind and would assist men whenever they returned, sometimes for a day or so, taking some food and bringing home the small fish which could not be commercialized, as well as the viscera. Sara has a photovoice about preparing snacks for her father Eusébio when he had left the community during the pirarucu fishing season. She prepared fried bananas for him, which were a very common snack and highly important in providing kilocalories to diets, as shown in the results from dietary recalls reported in Chapter 2 (Figure 19).

> *"I made fried bananas for Dad, because he left the lake today early to bring fish for us and had not yet had breakfast. He was cleaning the fish by the river, and sent a message through my aunt for me to make him some breakfast. I quickly went ahead to make it because he had left the lake before dawn and should be very hungry. I fried four green plantains* [banana comprida type in Portuguese] *sent five bananas* [banana maçã type in Portuguese] *for him to take too."* (Sandra's narrative for "Fried bananas" photovoice)

Figure 19. Sara's photovoice: "Fried bananas."

During the year of 2014, most men did fish, but did not received the payment, because their buyer did not fulfill the contract. In 2015 they decided not to participate in the pirarucu fishing season mostly due to commercialization problems and low benefits in relation to cost of fishing materials.

Many men talked about pirarucu fishing being as intense work, as they would spend all day in the sun and sometimes have to carry the fish long distances. The pirarucu rises to the water's surface in order to breath, and that is when the fisherman needs to be prepared to harpoon it. Pirarucu is one of the largest freshwater fish. The minimum size for legal fishing in that region is about 5 feet, and the average weight of the 2015 catch throughout the reserves was 120.8 lb. (IDSM 2016a). Many times, the designated lakes are relatively far from the communities and men need to carry the fish to the nearest water body connected to the river. A lot of the fish is sold regionally, including during the traditional pirarucu fair in the town of Tefé, organized by the IDSM (Figure 20)

The management of lakes and fishing of pirarucu has been one of the main IDSM research fronts. The program of participatory management of pirarucu started in 1998, when the institute got involved in participatory research manly with the goals of natural resource conservation and developing sustainable management strategies with the involvement of the community. The pirarucu program has been recognized as one of the most successful community development achievements of the IDSM, with community members responsible for counting fish populations in lakes yearly and collaborating in designating quotas for "no-fishing lakes" each season, policed by themselves. Although the specific communities with which I worked decided not to participate in this activity in 2015 due to not being able to secure a reliable buyer. More than 11,000 pirarucus were fished in Amanã and the neighboring Mamirauá Reserves, during the stipulated season (IDSM 2016a). The history of collaborative research on sustainable management of natural resources conducted by the IDSM, illustrated here in the case of the management of pirarucu, has assisted in training residents of the reserve, as well as in developing an understanding of resource conservation and sustainable use reflected in the photovoices below, produced by Samuel (Figure 21) and Gerson (Figure 22). In

Gerson’s photovoice, he mentioned his father is an environmental ranger (*agente ambiental*). The IDSM program of community management provides training in environmental education for residents who volunteer to participate. In 2015, more than 400 community leaders had received training through this IDSM program (IDSM 2016b).

Figure 20. Pirarucu were displayed and available for sale in Tefé in 2014.

"A while back, my brother went pirarucu fishing, and there, by the lake, he found a tracajá [yellow-spotted river turtle] *pit. The pit was filled with eggs. He then got a bag, put the eggs inside with the* matupá*, and brought it home. He told me to attend to it every day, until one day the little tracajás hatched out of the eggs. I got them, put them in a bucket filled with water and left for some time. Then my brother took them and put them in a tank. My mom wanted to release them back in the river, but my brother didn't. I don't want to release them either. Geez! They're so yummy!"* (Samuel's narrative for "The little *tracajás*" photovoice)

Figure 21. Samuel's photovoice: "The little *tracajás*."

"It was 4:30 in the morning when I went to check the gill net hoping to find a tambaqui. I got there and the net was heavy and tangled. I thought it was an alligator, but it was a pirarucu. It was time to fish tambaqui, not pirarucu, but even so, I could take it to eat. If I had found it alive, I would have released it; but since it was already dead, I brought it back to the community and shared with my neighbors. My dad is an environmental ranger, and he always speaks about conserving animals, otherwise in a while they will be gone."

Figure 22. Gerson’s photovoice: “The Innocent Pirarucu.”

FINAL REMARKS

This chapter gives a description of everyday life in Amanã as experienced during my time living in Santo Agostinho, the largest community researched and a central place for other smaller nearby communities and localities. I first addressed the formation of the Amanã Sustainable Development Reserve (RDS Amanã), the history of occupation, and its intimate relationship with the creation of the Mamirauá Institute for Sustainable Development (IDSM).

Here I depict how the historical presence of the Catholic Church is still reflected in the everyday lives of many communities, but how other churches, such as the Seventh-day Adventists and the Assembly of God, are gaining ground in more recent times. The accounts presented here show how outside influences create tensions and agreements, experienced by participants in their everyday relationships. When focusing on the presence of the church, these accounts illustrate how community members navigate among different religions, both in terms of identity differentiation and in terms of building community and social support.

I also focus on the position of women in the communities, both by giving accounts of how they are subject to prejudice and violence, as well as by showing their gradual acquisition of respect and political standing within and outside communities. This is illustrated by the strong presence of women as church leaders, and in important professional positions in communities, such as teachers and health agents, as well as in partnership projects with IDSM and other NGOs. Throughout this chapter I present an emic perspective from adolescents, reflecting their participation in productive activities, and their aspirations in the context of Amanã.

CHAPTER 2: EVERYDAY FOOD CULTURE AND THE ENVIRONMENT IN AMANÃ

INTRODUCTION

Hiding from afar, with fears of encountering a jaguar that killed one of her father's cattle, Marluce used the camera zoom to take a photograph of the cattle and then bring it to our discussion group, which was happening the next day. That day she was feeling unlucky, not because of the jaguar situation, but because although she did not have to go to school (it being a weekend), her brother Emersom was sick so her father made her go with him to tend the cattle instead. She would much rather have stayed home, sleep a little more, and do her usual household chores of cleaning and washing clothes by the *girau* in the back of her house. Her photovoice is presented below (Figure 23):

> *"My father always goes down river with fear of jaguars eating the cattle. On that day my brother had a fever and my dad said to me: - you will come feed the chickens and I will milk the cow. It was a Sunday and I didn't want to go because I was cold, and would have to wake up at four in the morning. Once we got there, the cow was crying and my dad found her calf dead inside a hole, just skin and bones. From the bacuri tree, my father shouted that the jaguar had been there. I got scared, and from the hut I took a chance and pressed down the camera zoom to take this photo."* (Marluce's narrative for "The Cattle" photovoice)


Figure 23. Marluce’s photovoice: “The Cattle.”

I would not describe Marluce as an easy child, and neither would her parents, Dores and Pedro, or her siblings, Paloma and Emersom. During my fieldwork, Marluce was very direct about disliking some of our photovoice discussions, and never missed a chance to fiercely point out how silly and tedious my questions were. My first trial on conducting a dietary recall with her was a disaster, and I had to disconsider the one day of work completely. This was because she decided to “impress me” (in her words) by not eating *farinha* (manioc flour) for a day, even though we had discussed beforehand that the idea was that she should not change her dietary patterns due to this activity, and that I was interested in recording food consumed throughout a usual day for her.

However, on that one day “tossed” from my sample, Marluce reported to me eating industrialized items that were not unusual in her diet: 3 bread rolls at breakfast, corn puffs and cookies in the late morning, then corn puffs again (after dinner) followed by a lollipop. Emerson, whom I had interviewed 2 days before, reported eating cookies and 3 ice pops after dinner (he had bought them from a household that had a generator running for long hours during the day, different from the usual 3 hours in the evening when the community generator was on). These industrialized foods were common in all the dietary recalls I conducted with Marluce and Emerson, along with other locally sourced foods such as fish, various fruits, some game, and of course, farinha.

Pedro, Marluce's father, had a reputation for being an extremely hard worker and was one of the people who produced the most farinha in the community, often assisted by Emersom. Her mother, Dores, worked mostly at home doing basketry. She also did some of the household work, but this seemed to be a routine responsibility of Paloma and Marluce. With time, I felt very comfortable in their house: Dores was one of the most respected and knowledgeable women in the community and I was able to learn a great deal from her. It was with her that I learned about many of the foods she processed or prepared such as *farinha de tapioca*, *frito de massa de macaxera puba*, *peixe salgado com abóbora*, and *pupeca*[c], which she, along with Helena, her sister who lived next door, gladly and patiently described, showed, and offered to me throughout the time I spent there.

The account above sets the stage for the detailed dietary data described in this chapter, with some of the key elements I later use to contextualize the changes I observed in Amanã. As an outside researcher in these communities, I experienced a lot of suspicion related to my work, and it took me time to build rapport. Eventually, I became good friends with many of the women and adolescents, such as Marluce, and began to understand that Marluce was right

[c] Respectively: manioc starch flour, fried manioc dough, salted fish stew with squash, and fish grilled wrapped in banana leaves.

about fearing the jaguar, but that other subtler risk, in the form of lifestyle changes, was also announcing itself in Amanã.

From the general framework presented initially in this dissertation, this chapter takes a closer look at the links between seasonal environmental changes and food consumption, considering the rates of parasitic infections between groups and highlighting routines and activities of adult women and adolescents, inside and outside the household. The analysis is centered on the effects of environmental conditions, measured as seasons, on food consumption. These effects are then contextualized taking into consideration rates of intestinal parasitic infections, subsistence activities, gender roles, and cultural practices. These elements are highlighted in Figure 24.

THEORETICAL BACKGROUND

The theoretical approach of this chapter is one that uses everyday food consumption practices as a basis for the contextualization of diets, also including aspects of people's productive activities and social roles. I describe here the ordinary consumption of everyday meals in the context of households of low socio-economic status (based on member's income per capita, as described in chapter 3) located in relatively isolated rural areas in the Amanã Sustainable Development Reserve. This chapter is rooted in theories of practice (e.g. Bourdieu 1990; Ortner 1984) emphasizing the actions, the material, and particular individual stories in everyday routines (Abu-Lughod 1991). Many scholars have enthusiastically employed theories of practice in the realm of food anthropology and consumption (e.g. Wilk 1997; Warde 2005; Sahakian and Wilhite 2014). In using these approaches, I attempt to give attention to meanings of consumption tied to cultural and social values, while mainly focusing on the material to empirically analyze consequences to mother's and adolescent's health.

Another important set of theories used in the framing of this chapter is cultural ecology (Steward 1955) and its later manifestations in environmental anthropology bridging human dimensions into the larger social ecological processes (e.g. Moran 1993; Brondízio 2008; Brondizio, Adams, and Stefano 2016). This approach is pertinent given the crucial role of the environment in the daily lives of the residents of Amanã, where natural resources have been and are constantly managed for use in a variety of productive activities, and are essential considering that the river itself is the way people access markets and services. The intersection of these theories with nutritional anthropology commenced with the notorious energy and protein limiting factor debate in the Amazonian literature (e.g. Meggers 1954; Lathrap 1965; Carneiro 1970; Gross 1975; Beckerman 1979). Recent developments in nutritional anthropology of the Amazon have produced exciting new research, especially incorporating principles of ecology and current regional patterns of nutritional change. A nutritional ecology approach takes into consideration the theories developed about food and cuisine in the Amazon since the 1960s, and places the necessity of empirical and primary data at the center of the analysis, especially for rural populations (Murrieta, Dufour, and Siqueira 1999; Adams and Piperata 2014).

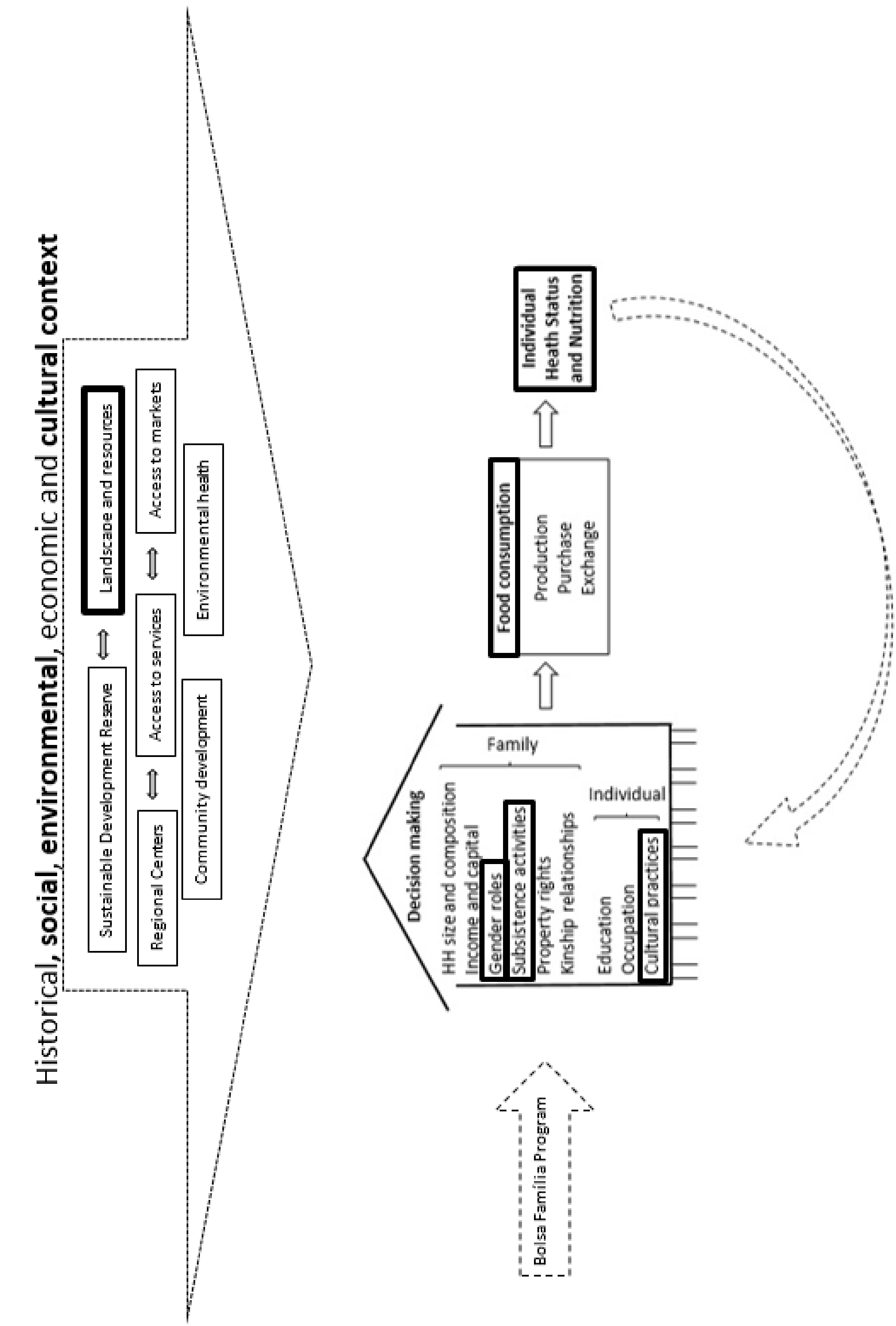


Figure 24. Dissertation framework with chapter 2 key elements highlighted.

Furthermore, the social roles of women and adolescents in activities linked to food production, preparation, and consumption were observed. These roles were considered part of constructed categories, according to their place and social reality. This research was also grounded in the work of anthropologists who challenged gender assumptions regarding maternal care and power, especially in settings of extreme poverty (e.g.Scheper-Hughes 1993) and within the household. As much as possible, I employed an emic perspective, using participant observation and women's and adolescents' discourses and practices from their everyday activities, which is explicit in the methods and discussion of results.

DIETS AND CUISINE

"If food is a code, where is the precoded message?" (Douglas 1972);

"A language is made of sounds, a cuisine of foods" (Weismantel 1988: 1139).

The two sentences above are from seminal works by Mary Douglas and Mary Weismantel, and come at the very beginning of their meticulous analysis of the American cuisine and of the Zumbagua cuisine of the time respectively. Both authors clearly recognize a distinction between diets and cuisine (or meal structure), which I will make use of in this chapter. Diets are considered food elements, the proportions and nutritional contents of meals, whereas the cuisine or meal structure refers to specific set of norms and exceptions for consumption, and how these meals are put together and combined. In their work, Weismantel (1998) delves into the diets and cuisine of the Zumbagua, while Mary Douglas presents a complex framework for American meal structure and categories.

This chapter contextualizes diets of mothers and adolescents in the Amanã Reserve, especially regarding environmental seasonality and the relationship between this variation with the social and cultural practices in place. The theoretical background outlined in the above section played an important role in framing the main goals of this chapter as well as the specific objectives listed below. I start by describing the general cuisine and diets, followed by a detailed analysis of seasonal variation in diets of mothers and adolescents. I then present results from intestinal parasitic infections, potentially disrupting nutrient absorption, as well as a major cause of sickness in the context of the rural Amazon. Lastly, I discuss the findings in relation to the literature.

The main research question addressed in this chapter is: what are the diets and cuisine of mothers and adolescents in the social, cultural, and environmental context of the Amanã Reserve across seasons?

The specific objectives derived from the question above are:

1. To describe the cuisine and diets of mothers and adolescents living in Amanã;
2. To analyze the influence of seasonality on their diets;
3. To present results about intestinal parasitic infections; and
4. To contextualize the effects of seasonality in diets from a social and cultural perspective.

RURAL AMAZONIA: DIETS AND CUISINE

Regarding *ribeirinhos*, there are a few studies in the anthropological literature detailing their diet and cuisine, especially in the eastern part of the Amazon, although research in this area has been growing (Murrieta 2001; Adams 2002; Piperata et al. 2011). Overwhelmingly the literature focuses on macronutrient intake, mostly due to methodological limitations for micronutrient data collection and evaluation (Yuyama et al. 1992). A few studies suggest iron

(Murrieta, Dufour, and Siqueira 1999; Silva 2011) , zinc, selenium, magnesium, and copper deficiencies, and excessive sodium intake in the region (Yuyama et al. 1992); as well as a study with school children arguing for bush meat as a key source of micronutrients (Sarti et al. 2015).

In terms of cuisine, general practices have been observed at the national level in Brazil, for instance a desire for presenting an abundance of food, or recognizing lunch as the main meal of the day, in which some kind of animal protein should be present (Fajans 2013). In the Brazilian Amazon, other more localized meal structures and categories have been recognized: açaí as a validator food in some areas of the Pará state, without which people don't feel satiated (Siqueira 1997); the manioc-fish combination as the core element of the meal structure (e.g. Murrieta, Dufour, and Siqueira 1999; Piperata et al. 2011; Dufour et al. 2016); and greens and vegetables category as secondary ingredients, never prepared as a main or side dish, considered often a "not-food" (Murrieta 2001; Adams 2002).

Manioc cultivars are commonly distinguished as macaxeira ("sweet" manioc) and mandioca ("bitter" manioc), depending on the concentration of cyanogenic glucosides, ranging from low to high cyanogenic potential (cyanogenic glucosides are hydrolyzed to hydrogen cyanide when the plant is damaged). The former, macaxeira, has been described as having low cyanogenic potential, which is apparently not harmful to diets: it requires relatively simple preparation for safe consumption, including peeling the skin and then boiling or frying the tuber thereafter. Mandioca requires an elaborate process before being safe for consumption, mostly as farinha. Before processing, mandioca tubers possess high cyanogenic potential and are highly toxic to animals, including humans, with concentrations in the pulp reaching 470 to 500 parts per million of fresh weight (tolerable levels must be below 100 ppm (Dufour 1988; Wilson and Dufour 2002). In Amanã, mandioca fields are usually planted further from the houses, near a stream and a processing area called a *casa de farinha*. On the other hand, macaxeira is planted generally closer to the house, allowing for prompt harvesting and cooking at home. The process of making farinha in the communities studied is detailed in a section entitled “The importance of farinha” in Chapter 4.

OVERCOMING SEASONAL VARIATION

Another communality in literature on diets in the Amazonian region is a description of a relatively unstable intake of calories, with the rainy season representing a period of diet simplification (Murrieta and Dufour 2004; Adams, Murrieta, and Sanches 2005). This is due to factors associated with floods, limited availability of land, difficulty of harvest, lower fish density as water levels rise (Smith 1981; Moran 1993; Murrieta and Dufour 2004), as well as the seasonal variation in fruit harvest (Clement 2006). As mentioned in the section on the ecology of Amanã in the introduction of this dissertation, water levels in the Middle Solimões region can rise up to 14 meters between the rainy and dry seasons (Ferreira 1997).

The academic literature has recurrently recognized farinha and fish as the main sources for energy, and the importance of fish has been further stressed as the main source of protein. Protein levels appear to be satisfactory and often high, independent of the season. Studies show that adequacy in caloric content represents a restraining factor at times, especially in the rainy season both for rural and urban populations (Murrieta and Dufour 2004; Adams, Murrieta, and Sanches 2005; Gainette-Prates, Soare-da-Costa, and Garcia-Torres 2015). Conversely, a trend of higher consumption of sugars and vegetable oil in the rainy season has been associated with an increase in diseases such as diabetes and high blood pressure, as predicted in the nutrition transition (Piperata et al. 2011; Dufour et al. 2016).

LIVELIHOODS AND HEALTH

Livelihoods in the rural Amazon are mostly based on mixed strategies of subsistence and commercial activities, while the importance of governmental jobs and benefits have grown over the last few decades (Lima 2010; Piperata et al. 2011). Seasonality influences many spheres of life for a rural resident of the Amazon, and they require managerial knowledge and skills for surviving differences in resource availability and landscape change (e.g. Moran 1993; Castro 2000). Livelihoods in Amanã are heavily based on cultivation of manioc, and during the rainy season, fields are at risk of flooding rapidly. In the rainy season, however, the transport of manioc tuber or flour cargo is facilitated by the use of canoes in flooded areas, instead of having to be done by foot. Moreover, with a higher water level, travel distances to urban areas are reduced, facilitating access to markets and services.

Every single child, adolescent, woman and man in Amanã knows how to paddle a canoe, which is not a trivial task. The river has various currents that move differently throughout the year, and people are very skillful in paddling to their desired destinations. In general, small motors (*rabeta*) are attached to canoes for longer distances travelled, and men or young boys operate them, although women and girls often know how to as well. Women and adolescents are involved in many of the productive activities, including cultivating manioc fields. There are certain activities that are mainly conducted by men, such as clearing forested areas for planting fields, pulling manioc plants off the ground during harvesting, and carrying the tubers to the *casa de farinha*, where they are processed. Women, children, and adolescents have been described as participating in other activities from plating, processing of the tuber, packing, and transporting products (Murphy and Murphy 2013).

Home gardens are often seen as female spaces in which women attend and rebuild gardens year-round (Murrieta and WinklerPrins 2003). Also, in this area of the Middle Solimões, many women have been dedicating time to weaving baskets, sometimes contributing significant income to their households. Additionally, in some communities, there are a few school teachers and health workers who limit their time dedicated to cultivation and fishing, sometimes ceasing these activities completely. Children are often active foragers of fruits and many boys become prodigious fisherman at a young age, often providing fish for the entire family. Fishing and hunting are primarily male activities and food preparation in the household are taken care of by women or adolescent females. Among adolescents, it is common for the oldest female child to stay in the household taking care of youngsters or, to be sent to work in other people's households in the communities as nannies.

The activities described above offer risks to health and, in isolated rural areas of the Amazon, people often lack governmental assistance and access to quality health services. Risks associated with fishing vary from a small injury from a piranha bite, to severe accidents such as alligator attacks or drownings. Snake bites, injuries from climbing palm trees to harvest fruits, or from using machetes in various activities are also quite frequent. The challenges for the health of Amazonian populations include difficult access to health services and lack of good sanitation, both of which compound poor health conditions (Silva 2009; Brondízio et al. 2016). Risks vary from severe illnesses as a result of diseases such as leprosy, malaria, and leishmaniosis, to poisonous snakebites, sting ray stings, skin infections, poor oral health, respiratory problems, and other conditions. This population suffers from not receiving prompt diagnoses and treatment associated with health risks posed by their livelihoods and environment (Silva 2009).

In terms of diets, chronic malnutrition associated with low stature of indigenous populations and ribeirinhos in the Amazon has been widely reported in the literature on public health status in the region (Dufour 1991; Santos and Jr. 1996; Piperata 2007; Lourenço et al. 2008). Recently, there has been a consensus among researchers that low stature is not adaptive or solely a result of genetics, but mostly due to fluctuations in caloric intake, associated with seasonal patterns, as well as high rates of intestinal parasitic infections (Adams 2002; Bender and Dufour 2012; Dufour et al. 2016).

Malnutrition and parasitic infection are part of a cycle in which “malnutrition promotes infection and infection leads to malnutrition” (Koski and Scott 2001: 299). Chronic gastrointestinal infections indeed contribute to widespread morbidity and mortality worldwide, but the particularities of pathways influencing this malnutrition-infection cycle are still unclear. Recent research evidence has linked protein, energy, zinc, and vitamin A deficiencies to impairment of the immune system during nematode infections, although single deficiencies do not appear to suppress all immune responses. In addition, the presence of single or multiple deficiencies, as well as concomitant infections by various parasites are key for addressing the magnitude of the effects to human health (Koski and Scott 2001). The scant research on this topic in the Brazilian Amazon indicates that intestinal parasitic infections disrupt nutrient absorption, and have been demonstrated to be a leading cause of sickness and death among indigenous groups in the Amazon (Coimbra Jr. et al. 2004). There is also indication of parasitic infections linked to rates of anemia among rural Amazonian populations (Murrieta and Dufour 2004; Silva 2011).

As a counterpart, a currently active area of research in parasitology has been aiming to understand the composition of intestinal microbiota, as well as beneficial effects and metabolic changes induced by intestinal parasitic infections in humans. Researchers have successfully argued for intestinal parasites' protective roles in immune response, as well as in regulating metabolic diseases including obesity-induced type 2 diabetes and the metabolic syndrome, when infection at low levels is considered (Shea-Donohue, Qin, and Smith 2017). This is rooted in the hygiene hypothesis where frequent infections during childhood produce protective health effects later in life, as well as a long documented history of co-evolution between humans and intestinal parasites (Roduit et al. 2016).

In regions with endemic parasite infections, as is the case in many areas in the rural Brazilian Amazon, adverse effects to the immune's system defense in favor of chronic intestinal infections seems more likely. This is because of poor sanitation, limited access to drinking water, fluctuation in kilocalorie intake, signs of chronic malnutrition, and a possible double burden of obesity with the rise in consumption of industrialized foods and lower physical activity reported in recent studies (e.g. Silva and Padez 2010; Nardoto et al. 2011; Piperata, McSweeney, and Murrieta 2016). Therefore, in order to understand the general nutritional status of participants, an evaluation of the types of intestinal parasites and presence of multiple infections was conducted along with a dietary analysis in different seasons.

The above circumstances differentially affect the health status of residents in the rural Amazon. For instance, mothers may use a "nutritional buffering" social strategy for dealing with variations in food availability in order to safeguard children's development (Piperata et al. 2013). This is a recurring argument in the context of poverty (Fitchen 1987; Van Esterik 1999) in which mothers reduce intake to compensate for their children.

METHODS

In chapter 1, I presented a detailed account of the communities studied. For this chapter, it is important to bear in mind that the communities considered here are located in fertile areas along tributaries of the Japurá white water system, and that livelihoods in Amanã are heavily based on agriculture, especially the production of farinha for consumption and trade. In addition, the active presence of the Catholic Church "Movement of Grassroots Education" in the 60s and 70s, followed by the guidance of the Mamirauá Institute for Sustainable Development Research, instilled engagement of residents in environmental and social issues, especially regarding community organization and natural resource conservation.

DATA COLLECTION

During a period of approximately a year, between February of 2014 and February of 2015, I collected data in communities located at the Amanã Reserve. I stayed most of the time living with different families in Santo Agostinho, and returned to the nearest town monthly to gather supplies, carry out interviews, and conduct preliminary data analysis. A detailed description of data collection and of my experience conducting research at Amanã is included in the introductory chapter of this dissertation.

As stated previously, the main goal of this chapter is to understand the diets of mothers and adolescents in the context of communities located at Amanã Reserve across seasons. In the introduction of this dissertation, I justify the exclusion of men and younger children from the sample, related to the focus of the Bolsa Família program and research limitations. The methods were derived from each specific objective and are outlined below:

1. Specific objective 1: to describe the cuisine and diets of mothers and adolescents living in Amanã

The methods used to attain this specific goal were mainly participant observation, and 24-hour dietary recalls. The results section begins with a description of the basic structure of meals consumed in the household and its core elements. Data on 24-hour dietary recalls conducted with mothers and adolescents provide a rich record of the components of diets, including times of consumption, food ingredients, recipes, and amounts.

2. Specific objective 2: to analyze the influence of environmental seasonality on the diets of mothers and adolescents;

24-hour dietary recalls were conducted with women and adolescents in multiple occasions during the year, at different seasons, in order to understand dietary variation in food consumption. Descriptive statistics and linear mixed models (LMM) of the dietary recall data across seasons are presented in the results section.

3. Specific objective 3: To present results about intestinal parasitic infections;

Fecal samples from women and adolescents were collected one time during the year and sent for analysis at a local laboratory located in the town of Tefé. The details about data collection and method of analysis are outlined at the end of this section.

4. Specific objective 4: To contextualize the effects of seasonality in diets from a social and cultural perspective.

All specific objectives were addressed using 24-hour dietary recalls, census data, participant observation, and ethnographic interviews. The methods and data collection are detailed below.

CENSUS

I developed a household census survey which was conducted in all households located in the communities studied. While a researcher from the Federal University of Amazonas working on a partner project conducted most of the census interviews, I accompanied all interviews and conducted a few of them. In each household, we used a structured questionnaire to collect data on demographics, including household composition, age, and education. Data about main economic activities, sources of income, and social benefits received were included, as well as variables on food production, consumption, frequency and places for food purchase and exchange within the community. The interview lasted between 15 to 40 minutes depending on the size of the household. The interview was conducted with an adult woman, but in most cases questions were answered by the whole family together, including the spouse, children and sometimes parents, when present. All households in the communities studied, a total of 48, responded to these questions, including the ones in which no other data collection was conducted. That was the case for five households, two in which single senior men lived by themselves, one in which a senior woman lived with an older granddaughter, and two in which respondents did not agree to participate in any of the other research activities.

PARTICIPANT OBSERVATION

A typical day for a researcher conducting participant observation in isolated communities drastically change as time goes by, as people become comfortable with one's presence. By chronologically evaluating my field notes I realize how close I became to a few of the women who participated in my research, and how I started to gradually adopt some practices that were in the beginning foreign to me. After more than 6 months of visiting the community for long periods of times, I knew everyone's names, including the children and the elderly, which conditions each person was suffering from or going through, how they were dealing with those, how kids were doing at school, domestic conflicts between couples, major troubles and the history of relationships among relatives, and so on. Also, to a certain extent, I became a resource to the community: I would bring news from relatives who were distant or in trouble (e.g. from a girl who ran away from her family), bring different seeds and vegetables to and from other communities, assist with activities of the weaving baskets group of women, etc.

As in many anthropologists' fieldwork accounts, I was quite often a source of amusement for the community given my lack of ability to carry out what they considered the simplest activities. For instance, during my first week in the community my canoe turned over in a very calm part of a stream (I managed to save my camera from getting wet). I was rescued by a 5-year-old girl whose river paddling skills were and are far better than mine. Another example was the long laughter I would hear after telling a story about my experience preparing a fish they call *sardinha* while I was in the nearest town by myself. I did not know about their clever technique for precisely cutting parallel lines through the fish bones (*ticar*), so they can be swallowed, rendering the eating small fish an easier and safer task.

Gaining rapport was certainly a result of my social interactions in the community, which, as stated previously, were not always pleasant. As described in the introductory chapter of this dissertation, the methods I used were not always received as appropriate ones, and most respondents were sincere about not participating in certain activities because they thought I was either invading their privacy, or because they found it boring, excessively time consuming, or even linked to conspiracies, and so forth.

A typical day is also difficult to describe considering the variety of activities conducted throughout the year, the extreme environmental changes associated with seasonal fluctuations, and the different social roles expected of individuals in the communities. Generally, however, people would wake up early, around 4 to 5am, to avoid the extreme heat of late mornings and afternoons. Many of the women in their 50s would listen to the radio at this time as they prepared snacks for family members to take in whatever was planned for the morning. Men might head to the manioc fields or fish alone or in small groups (including with women, adolescents, and children). Fishing was also done with flashlights at night (*faxiar*). Other activities might include trips to places further afield to sell goods, or assistance in house or canoe construction, and so forth.

Mostly women and a few men in their 20s and 30s who were teachers would leave for work at the school in the early morning or afternoon. Children would go to school at seven in the morning, after usually eating breakfast at home prepared by their mothers (or in some cases by the oldest female sibling). Adolescents would go to school in the afternoon, so in the mornings they would either accompany their parents as helpers in whatever activities they were doing, or stay home cleaning, washing clothes, cooking, taking care of siblings, or they would go help relatives with similar activities in other households. Many boys would leave in groups of two or three to fish, and girls would commonly help with cleaning dishes, washing all family member's clothes, clean the house, and other household obligations. The school was either a few steps from their house or in a nearby community.

In the Middle Solimões there is a great sense of community permeated by kinship relations which are viewed broadly, a characteristic that has been described thoroughly in the literature by (Lima 1997) and I observed its full extent in the communities studied. Church activities were an important part of the life in the community, especially on weekends. Most members of the largest community were Catholic, gathering almost every Sunday when service was conducted by a rotation of women and men mostly in their 50s and a group of young men and women between 15 and 20 years old. Most residents of the closest smaller community studied were Adventists, and in the third community studied most residents were members of the Pentecostal Assembly of God denomination. Parties affiliated or not with the church, and events such as soccer tournaments and Mother's Day celebrations were also frequent.

I accompanied mostly women and adolescents in many of the routine activities mentioned above, sometimes as an observer and sometimes helping as much as possible. These activities varied from cooking to washing dishes in the river, clearing fields, processing manioc tubers for different food products, harvesting, tending gardens, fishing, catching shrimp, collecting plants and processing them for basket weaving, hunting, searching for fruits, organizing community parties and events, accompanying community health workers in some of their daily activities, participating in church gatherings, attending school events, travelling to town together, accompanying women to events or grocery buying, and so on. Food, I observed, is almost always a central part of these activities. Preparations and meal structures vary depending on the activities and social roles in different settings; either inside or outside the household, or during parties, informal gatherings during work or leisure times. Some of these are described in more detail in the Results section (Amanã cuisine) and in the Discussion.

DIETARY DATA

For a detailed methodology on data collection of dietary data, please refer to chapter 5. Here I will briefly describe the method and summarize the most important information for understanding the analysis conducted here.

I conducted 24-hour dietary recalls following Gibson and Ferguson's (2008) guidelines for the use of this method in developing countries. Essentially, at the end of an interview, I would have recorded all of the foods eaten by the interviewee during the last day, from waking up to going to bed. Data is recorded at the maximum level of detail including time of consumption, each ingredient of recipes and meals, and estimated amounts. The dietary recalls were intended to be performed with all subjects for 2 non-consecutive days (as recommended by IBGE 2010), and 3 times during the year, in the rainy, dry and transition seasons.

Dietary data using 24-hour recalls were collected from 41 individuals, of which 18 were mothers, between the ages of 29 and 54, and 25 adolescents between 12 and 15 years old. Given the time and dedication required for data collection and difficulties in finding subjects during the planned dietary assessment periods (and other variables such as pregnancy and drop out), only 28 of the 41 individuals completed six recalls during the year. Of the total, five individuals and six individuals completed five and four dietary recalls respectively, and two individuals completed only two recalls during the time of data collection (Table 2).

Table 2. Number of participants in the 24-hour dietary recall data collection

Participants	Age	Number of participants	Number of recalls (typical days)
Mothers	29 - 54	18	80
Adolescent females	12 – 15	10	48
Adolescent males	12 – 15	15	66

FOOD GROUPS AND CATEGORIES

Foods were grouped to facilitate analysis and interpretation. These are described below:

- The **seasonings** category included all ingredients used in small quantities to add flavor or color to dishes, they were: *alfavaca*, *chicória*, *cheiro-verde* (cilantro), *couve* (collard greens), *cominho* (cumin), *cebolinha* (green onions), *pimenta cheirosa*, *pimenta do reino* (black pepper), *pimenta ardosa* (various types of chillis), and *urucum* (achiote).
- The **game** category included wild animals hunted for food, they were: *cotia* (aguti), *macaco guariba* (brown howler monkey), *paca, peixe-boi* (manatee), *veado* (deer), *tracajá* (yellow-spotted river turtle), *jacaré* (caiman), *catitu* (peccary); and wild birds including *mutum, macucaua, alencorne, ariramba, pato do mato, jacamim*, and *marreca*.
- The **fruit** category included the following fruits (scientific names are provided in Table 6 of chapter 5): *abacaba*, *abacate*, *abiu*, açaí, *apuruí*, banana (including plantains), cacao, cashew, citrus, coconut, *cubiu, cupuaçu, guava, ingá, jambo*, *jenipapo*, mango, *marimari*, melon, pineapple, tomato, *tucumã*, and watermelon.
- The **fish** category included prepared fish (stewed, fried, grilled, and fish sauce) and also prepared shrimp (stewed and fried), the later seasonal and not frequent in diets. Vegetable oil added to stewed recipes were not included, and were used as a proxy for vegetable oil consumption, along with vegetable oil used as an ingredient in uncooked recipes (mixed with mashed bananas).
- The **chicken** category included stewed, fried and grilled chicken produced in the community or purchased from urban areas, the latter more frequently. Vegetable oil added to stewed chicken was also separated as another category.
- The **eggs** category included raw, fried and boiled eggs, mostly purchased from urban areas, but some were produced in the community or collected from wild animals (including alligator and turtle eggs).

- The **beef** category included meat from cattle, mostly from animals killed in the community or in nearby communities. Rarely people purchased meat from cattle in urban areas. The beef category included stewed, fried and dried meat, as well as stews made with the animal's feet (*mocotó*). Vegetable oil added to stewed beef was also separated into another category.

Based on the literature about diets in the rural Amazon, and on previous experience working in the area, the following items were singled out in the analysis in order to evaluate the importance of their overall contribution of kilocalories, proteins, and fats to diets; they were: **farinha**, **fried bananas**, **beans**, **rice**, **pasta, sugar, dairy powder**[d]**, and vegetable oil** (added to fish, meat and chicken stewed dishes and used as an ingredient in uncooked recipes).

Moreover, certain foods were often consumed in very small portion sizes or very infrequently, and were then grouped according to the level of industrial processing, adapted from Monteiro et al. (2011) classification. For a detailed explanation of the criteria for categorizing foods and recipes, and a detailed list of foods included in the groups outlined above, please refer to chapter 5.

A summary of the explanation of items included in each group used in this chapter is presented below:

- ***Group 0*** includes foods or recipes prepared with items that are unprocessed or minimally processed at home or at the community level and are referred to as ***unprocessed*** throughout this chapter. These include foods such as boiled yams and manioc, squash and corn. Farinha, seasonings, fruits, grilled fish and chicken, boiled eggs, would fit in this category but were excluded, and considered as single categories.

[d] Brazilian regulations (IN 28 of June 12 of 2007) define dairy powder as "a product containing at least 51% of dairy products (of the total mass weight) and other non-dairy substances suitable for human consumption."

- ***Group 1*** includes recipes in which the core ingredient does not involve any industrial processing, but recipes require the addition of industrially processed ingredients. This category is described in chapter 5 as “unprocessed or minimally processed in industries, or cooked at home with food industry ingredients” and are referred as ***mix processed*** here. These include foods such as banana or corn porridge, manioc and corn cakes, and coffee. Fried bananas, rice, beans, game, fish, chicken, and beef (fried or stewed), and fried eggs would fit in this category given the use of vegetable oil in preparations, but these items were excluded, and considered as single categories.
- ***Group 2*** includes foods items which are used as ingredients in dishes and complements in uncooked snacks, described as processed culinary or ***food industry ingredient*** in chapter 5. These are items such as chocolate powder, margarine, and tomato paste. Sugar, pasta and dairy powder belong to this group but were excluded and considered as a single category.
- ***Group 3*** includes ultra-processed foods such as breads, sausages, canned meats, lollipops, and chewing gum. Here this group is referred as ***ultra-processed*** in chapter 5***.*** No items from this group were singled out given the low frequency of consumption of any particular item from this group, granting the group great diversity as it contains 35 different items.

DIETARY DATA ANALYSIS

As in chapter 5, only recalls which were considered typical by the respondents were included. In total, 28 recalls considered atypical were excluded. The main reasons for participants to consider the day as atypical were because they included unusual foods consumed in party events in the community or nearby communities, or because they had recently arrived from urban areas, or had a relative or friend send a special food item. There was one who considered a recall as atypical because of consuming game, which according to her was quite rare in her household.

The general analysis framework for the dietary data is provided in this section, and details particular to each model are explained in the results section. The main differences between the analysis performed in this chapter and chapter 5 is the organization of data. While in chapter 5 recipes were combined by the level of industrial processing of a certain food item or recipe, the focus here is to understand variation in macronutrient intake consumption, and the importance of certain food items across seasons for different generations.

The Nutribase software (*NB11* [version NutriBase 11 Pro Edition] 2011) was used for data input, but many of the regional foods had to be imported from a national database with (TACO 2011) as a reference. The Nutribase database dietary data uses compensated 4-4-9 conversion factors for USDA data to calculate values of percent calories from carbohydrates, proteins and fats. Given that no conversion factors exist for many of the regional foods, I opted to use the Atwater method (still recognized as an official method by the Association of Analytical Communities - AOAC) for calculating the daily average percentage kilocalorie intake from carbohydrates, protein and fat (4-4-9 Kcal/gram), so values were standardized and comparable, but not necessarily accurate. There are many limitations to this analysis, including possible variation in the nutritional content of items, depending on environmental variables, as well as substitutions made because of unavailable and inconsistent data. The substitutions used for calculating nutritional content of foods in this were all conducted using TACO (2011) references.

For adult women, energy requirements were estimated according to (FAO/WHO/UNU 1985) considering moderate levels of physical activity during the dry season, and light during the rainy season, given that women are less active as transportation is mainly done on motorized canoes as opposed to walking long distances. Similar levels of activity were used by Murrieta and Dufour (2004). For adolescent males and females, the requirements were based on the median weight, as recommended in FAO/WHO/UNU (1985), based on levels of activity desirable for development and growth. Data on macronutrients intake was aggregated at the individual dietary recall level for all participants.

For the dietary data analysis, generalized linear mixed models (LMM) were used in order to account for various levels and longitudinal data (Demidenko 2013). LMMs are used when dealing with nested structures from measurements nested within participants. Each season nests two dietary recalls from each participant who had consumed a number of food items, which are nested under that participant, recall, and season. This is a multilevel model with complex hierarchical group data suited for analysis using LMM. LMM were also selected given that measures were repeated with each participant. Models include random effects for each participant, so data independence assumption is not violated (each subject is assigned a different intercept, estimated by the model, a general across the board error term). Moreover, the model assumes the presence of missing data.

The independent variable in the models are related to dietary intake, either total kilocalories consumed in a day, or amounts of carbohydrates, proteins, or fats consumed in a day for each food type or category. For all samples, in looking at the effect of season on macronutrients intake, the selection of co-variates was considered in terms of their theoretical relevance, as well as in terms of avoiding multicollinearity and contribution to explanatory models (lower Akaike's Information Criterion - AIC). For instance, height and weight were both tested as control variables in models, and included when assisting with an explanation of differences. Income was tested as total household income, percentage of total income accounted for by the BFP, or income per capita; the latter in order to account for household size. All income calculations are detailed in chapter 3. For none of the models presented using mother's data, the inclusion of income as a co-variate entailed a change in the significance of other co-variates, or increases to the model's fit (when any of the variables related to income were included, AIC was higher).

The addition of random intercepts by individuals in the models reflect an idea of similar change in macronutrient and food types across subjects due to seasonal variation (parallel personal regressions). Although the addition of slopes varying across incomes is theoretically sound (non-parallel regressions), it is not coherent for the models presented due to income data collection being performed once during the year, and given the presence of steady sources (details in Chapter 3). The addition of random slopes varying across seasons was tested for in models using mothers' data, and no significant differences were found between them and the models presented here (including only random intercepts).

The data for creating the plot figures was organized so that it would be balanced across food types. There were always 20 food categories per recall, which were recorded as zero when not reported as consumed. The general LMMs included data aggregated by recall. The models looking at specific food categories comparison used daily intake of those specific food types per recall across season. All outputs for the models analyzed were included in Chapter 2 Appendix as presented in the R software (R Core Team 2015) using package "lme4" (Bates et al. 2015). The process of including or excluding variables from the model, based on the distribution of the residuals, is detailed under each result section.

Daily average requirements

For adult women's dietary adequacy comparison, physical activity was considered as moderate (1.75 Basal Metabolic Rate multiple) in the dry season and light in the rainy season (1.6 Basal Metabolic Rate multiple), age range between 30 and 60 years old, and weight equals to 55 kg (average of measurements in all seasons was equal 55.1 kg). Daily average requirement for the adult women sample would be 2050Kcal in the rainy season and 2250 Kcal in the dry season, and safe level of protein intake equals to 41 g per day (FAO/WHO/UNU 1985).

The estimated requirements for adolescents are based on weight rather than age. This is recommended given the variability in adolescent growth spurt timing. For adolescent females, the median weight was 40.9 kg (average equals 43.4 kg), considering all seasons. This value is significantly lower than the one considered at the FAO/WHO/ONU (1985) estimate requirement table for ages 12-14, of 46.5 kg. Given the difference in weight, the daily requirements were calculated as recommended in FAO/WHO/ONU (1985), relative to BMR, coming to a daily requirement of 2027 Kcal for female adolescents of 40.9kg median weight. For adolescent males ages 12-14 weight values from the sample did not differ from the FAO/WHO/ONU (1985) estimate requirement table (43.1 and 43kg respectively). The estimated average daily kilocalorie intake requirement for adolescent males is 2400 Kcal daily, and safe level of protein intake is 43g per day (FAO/WHO/UNU 1985).

Linear mixed models: daily kilocalorie intake

The LMM used to test the effect of seasonality on dietary intake of adult mothers and adolescent females included height as a covariate to make a more robust model. Weight was not included given the high correlation with the height variables. For male adolescents, height and weight were not included model because neither assist in explaining variation in intake.

Linear mixed models: food sources

I investigated how much the main food categories contribute to energy intake, protein, and fat in individual recalls by season. The average kilocalorie contribution of each categorized food item was calculated based on the percentage contribution in each food recall per season. The ranking of importance in caloric contribution informed the analysis of the effects of season on the consumption of specific food items.

Kilocalories by food type

Considering each food type, a linear mixed model was used to estimate the effect of seasons on kilocalorie amounts by food type. For all models, a log transformation of the dependent variable was necessary to obtain a normal distribution of the data, and a random distribution of the model residues. The difference in estimates was calculated by subtracting estimates across different seasons (e.g. Δ log season = estimate log season 1 – estimate log season 2). The percentage change between seasons was calculated by the exponential estimate of a certain season compared to the reference, the rainy season. ($\%\Delta season = 100 \times$ $(e^{\Delta \log \text{season}}$ -1). The R outputs for all models are in the Chapter 2 Appendix, as well as the distribution of the model residuals (assumption of LMM as random).

Sample sizes of dietary recalls with adolescents, females and males, were smaller than recalls conducted with women. Because of that, the LMM was used to compare the most significant foods contributing to daily kilocalorie intake, as informed by the daily average contribution of each food type. The food types or categories considered for female adolescents were: farinha, other highly processed foods (group 3), fried bananas, prepared fish, fruit, crackers, other industrially unprocessed foods (group 0), vegetable oil added to dishes, sugar, other mixed prepared foods (group 1), other industrial food ingredients (group 2), rice, and pasta. The food types or categories considered for male adolescents were: farinha, other highly industrialized foods (group 3), fried bananas, prepared fish, fruit, crackers, other non-industrially processed foods (group 0), vegetable oil added to dishes, sugar, other mixed processed foods (group 1), other industrialized food ingredients (group 2), rice, and pasta. In comparison with the food/categories considered in the adolescent female recall analysis, other mixed processed foods (group 1) were not included given that their importance and sample size was smaller for adolescent males. Considering all recalls with adolescent males, other mixed processed foods (group 1) were present in 2 recalls in the rainy season, 5 in the dry season, and 2 in the transition season, whereas for adolescent females the respective frequencies were 3, 5, and 5.

Protein by food type

For many of the other protein-rich foods, sample sizes were small, compromising the power of comparisons across seasons.

In the dietary data collected with adult women, eggs, game, beans, beef, and chicken appeared in less than 4 recalls in at least one season. Eggs were present in 1 recall in the rainy season, 3 recalls in the dry season, and 1 recall in the transition season; game was present in 2 recalls in the rainy season, 3 recalls in the dry season, and 2 recalls in the transition season; beans were present in no recalls in the rainy season, 4 recalls in the dry season, and 4 recalls in the transition season; beef was present in no recalls in the rainy season, 2 recalls in the dry season, and 1 recall in the transition season. Chicken was present in 6 recalls in the rainy season, but only in 2 in the dry season and in 1 recall in the transition season.

In the dietary data collected with adolescent females, eggs, game, beans, beef, and chicken appeared in less than 4 recalls in at least one season. Eggs were present in 2 recalls in the rainy season, 0 recalls in the dry season, and 4 recalls in the transition season; game was present in 0 recalls in the rainy season, 3 recalls in the dry season, and 2 recalls in the transition season; beans were present in 5 recalls in the rainy season, 1 recall in the dry season, and 1 recall in the transition season; beef was present in 2 recalls in the rainy season, 1 recall in the dry season, and 1 recall in the transition season; chicken was present in 2 recalls in the rainy season, 4 in the dry season and in 2 recall in the transition season.

In the dietary data collected with adolescent males, eggs, game, beans, beef, and chicken appeared in less than 4 recalls in at least one season. Eggs were present in 1 recall in the rainy season, 6 recalls in the dry season, and no recalls in the transition season; game was present in 4 recalls in the rainy season, 2 recalls in the dry season, and 1 recall in the transition season; beans were present in 4 recalls in the rainy season, 1 recall in the dry season, and 3 recall in the transition season; beef was present in 2 recalls in the rainy season, 1 recall in the dry season, and 1 recall in the transition season; chicken was present in 5 recalls in the rainy season, 2 in the dry season and in 1 recall in the transition season.

Moreover, foods which have zero protein, or presented more than half of recall entries recorded as zero grams of protein in a serving, or yet had particularly low median protein amounts were excluded from the model. For adult women and adolescents these were: sugar, oil added, fruits, other group 0 foods, and other group 2 foods, farinha, crackers, fried bananas, pasta, rice, seasonings, other group 1 foods, and dairy powder.

Given the limitations outlined above food types were considered separately and the analysis was informed by the general averages of protein contribution by food type. For all models, the LMM included daily protein intake as the dependent variable only for two food types/categories, prepared fish, and other highly industrialized foods (group 3). A log transformation of the dependent variable was necessary to obtain a normal distribution of the data, and a random distribution of the model residuals. The variable height was included in the models for adult women and adolescents given that it potentially influences dietary intake, and controlling for it decreased the p value. The R output for the model is in the Chapter 2 Appendix, as well as the distribution of the model residuals (assumption of LMM as random).

Fat by food type

For looking at the effect of season on women's daily fat intake; sugar, seasonings, rice, industrially processed ingredients (group 2), unprocessed foods (group 0), farinha, fruits, pasta, rice, and dairy powder were not included in the Linear Mixed Model because they do not contain any fat, or contained very small amounts per serving size. For adolescent females, the same food items were excluded with the addition of prepared fish to the above list. Even though fish and fruits appear to be contributing to fat intake overall in female adolescents' diets, the data was highly concentrated in two values, and therefore cannot be considered continuous, essential for inclusion in the model. For adolescent males, the same food items were excluded with the addition of locally prepared foods (group 1) to the above list, given that more than 70% of the group 1 entries were equal zero.

In the case of adult women, eggs, game, beans, beef, and chicken were not included in the LMM given the small sample size. The following food items/categories were included: oil added to meat dishes, fried bananas, fish, highly industrialized foods (group 3), locally prepared foods (group 1), and crackers. In the case of female adolescents, the same items were included, except for fish. In the case of male adolescents, the same items were included, except for locally prepared foods (group 1).

Again, a log transformation of the dependent variable was necessary to obtain a normal distribution, and a random distribution of the model residues. The percentage change between seasons was calculated by the exponential estimate of a certain season compared to the reference, the rainy season. ($\%\Delta season = 100 \times (e^{estimate}$-1). The R output for the models are in the Chapter 2 Appendix, as well as the distribution of residuals for each food type/category model (assumption of LMM as random).

PARASITIC INFECTIONS

To evaluate enteroparasitological infections, fecal samples from participants were collected during visits in July of 2015 and in November of 2015. Initial visits to households were done by a field assistant to collect the samples, and later I returned to the communities studied to present and discuss preliminary results of this research, collecting samples in remaining households. Samples were collected by participants using a collection kit with sterile containers provided by a local private laboratory. The material was kept in an insulated container filled with ice for up to 4 days (maximum period for analysis not to be compromised). The fecal samples were analyzed at a local laboratory located in the town of Tefé using the Hoffman method with direct examination widely used in epidemiological studies (Hoffman, Pons, and

Janer 1934). This method is the most commonly used in laboratories with few resources, given its broad range detection (helminths eggs, and larvae and protozoa cysts), low costs, and satisfactory effectiveness (De Carli 2007).

Data was collected with a total of 35 women, 11 adolescent females, and 8 adolescent male participants. All mothers younger than 65 years old in the community participated in this data collection, given that the method did not represent a high burden for the participants or the researcher. Of the 18 women who participated in the 24-hour dietary recall collection, three were travelling during the visits for stool sample collection, so there are no results about presence of intestinal parasitic infections for them, for adolescent females this number was two (one travelling and one did not want to participate – the extra two included were one adolescent whose family had recently moved to the community, and one who had turned 12 and asked to participate), and for adolescent males, seven (six were travelling and one did not want to participate)[e].

RESULTS

AMANÃ CUISINE

In general, main meals are constituted of a basic structure with two core elements. The two mandatory elements of a meal are farinha and a source of animal protein, prepared by boiling, frying or grilling (less often drying, and salting was common for some fish types, which was later unsalted and boiled). More commonly, fish is consumed as the animal protein, and

[e] A volunteer physician from the Brazilian army base located in the town of Tefé, Amazonas, accompanied me to the communities studied at the end of my second field visit, in October of 2015. The physician saw all participants and provided medicine to treat parasitic infections, based on the results from the tests conducted. This was a requirement of the local ethics committee. The fulfillment of this requirement was possible with the assistance of IDSM Quality of Life program staff.

less frequently, people substitute it with beef (including industrialized sausages and canned meats), game, or eggs. Besides these two core elements, there are secondary complements, which are occasionally present. These can be rice, pasta, beans, bananas, sauces made with cubiu, lemon and green onions, or tucupi (manioc juice and various condiments, often spicy), and so on. Sometimes it is acceptable to substitute a meal with juice from fatty fruits, such as açaí, patauá or buriti, accompanied by farinha and often sugar. These, however, are more commonly consumed as snacks.

Snacks are consumed throughout the day and the communities seem to have adopted the school snack breaks as part of their routines, especially when working in activities inside or near the household. In the morning, it is common to have a small breakfast around 7am and a *merenda* (snack break) at 9:30 am. The breakfast is usually coffee and a snack (e.g. crackers, bread, fried bananas, beiju, and boiled manioc). Coffee is always brewed and consumed with the addition of sugar, sometimes dairy powder (49% or less of non-dairy substances in the ingredients) and rarely powdered milk (100% milk in ingredients). Manioc starch flour (farinha de tapioca) is much appreciated in coffees and is consumed when it is available. The average proportion of ingredients in the preparation of coffee drinks was 1.2g of coffee grounds for 8.5g of sugar in 100ml of water. In the late afternoon and evenings, it is common for adolescents to snack on cookies (*bolacha recheada*), corn puffs (*milhitos*), lollipops, and ice pops (*geladinho*), the latter when available in one of the household who runs the generator frequently. Adolescents often share these items with each other.

Children are used to drinking brewed coffee with adults several times per day, sometimes accompanied by fried bananas (with or without farinha), crackers, bread, beiju, cooked or fried manioc tubers and yams, etc. Foods consumed in snack breaks were the same as breakfast or similar to what is provided in school, usually *mingau* (porridge) and fruit juice (commonly everyone in the community ends up eating whatever is provided by the school, given the habit of sharing food and the contained nature of the community); often the school runs out of food supplies from the municipality, so it has to be provided by the families, or relatives and friends of the school children, who return to these households during the school break to snack. Lunch is considered the most important meal of the day and is usually consumed between 11 am and 12 pm, following the basic meal structure outlined previously. Snacks can be consumed throughout the day whenever they are available, either when people are working in the fields or in the household. Fruits are more commonly consumed as afternoon other than morning snacks. Suppers are very similar to lunches, but in general, foods are consumed in smaller amounts, around 6 pm.

Seasonings are important in the preparation of animal protein dishes. A good fish sauce is described as having salt, black pepper, green onions, peppers (*pimenta de cheiro*), onion, garlic, and, in most cases, *colorau*. Colorau is a red dye extract from achiote (urucum) plant seeds, without any characteristic flavor, it can be either produced or purchased in nearby towns. Colorau is also an essential condiment in the preparation of chicken, which is viewed as "too white" for consumption. The use of peppers, green onions, onions and garlic is highly desirable. Peppers and green onions are usually produced in backyards whereas garlic and onions are purchased. Spicy peppers are also planted and usually consumed on the side when available. Other condiments are also consumed but are less common, such as colored greens, coriander leaves, alfavaca, etc. Manioc tubers, yams, squashes and similar vegetables are also used in slightly larger portions than condiments in the preparation of fish and meats. These are produced in backyards or in the fields in small quantities, and are all viewed as condiments: never prepared as a side dish, but always as an ingredient in dishes.

During my ethnographic work, I did encounter narratives about changes in diets over recent generations. Mothers and grandmothers talked about mostly having very different breakfasts as children, either composed of fried fish and farinha, or of açaí, bananas, and squash with farinha; crackers and other industrialized snacks did not seem to be present at all. Also, mothers commented on the taste preferences of children who would not enjoy having yams, cooked manioc tubers, or beijus in the morning, preferring to eat breads, toast and crackers. Even though fish and farinha are the predominant foods in meals and are mostly appreciated, there was some anecdotal indication of change. One mother had the habit of having açaí with crackers instead of farinha, and was mocked by others in her household and in the community. Moreover, in one household an adolescent did not like farinha and refused to eat it completely, substituting it for rice. Indeed, this family had settled for a number of years in a near town, before moving back to the rural area. In addition, Marluce, mentioned in the very beginning of this chapter, tried to stay a day off eating farinha and without having sugar in her coffee to "impress me". There is a lot of social interaction between these families and their friends and relatives living in urban areas, as well as a number of researchers from other regions of the country, including foreigners, especially biologists, who stay in some of these communities for short periods.

GENERAL DIETS AND SEASONALITY

Among the food sources of kilocalories in the diets of mothers and adolescents (male and females) recorded in the Amanã communities, farinha is dominant as the main contributor, followed by other secondary categories including prepared fish, fried bananas, other highly industrialized foods (group 3), and sugar (Figure 25a). In terms of protein intake, fish is the predominant food source; other highly industrialized foods come in second, however in minor quantities compared to the average protein intake from fish (Figure 25b). The main food sources contributing to fat intake are vegetable oil added to dishes and fried bananas (Figure 25c), the fat content of the latter accounted for by the vegetable oil used in its preparation. Crackers and other highly industrialized foods (group 3) are also a major contributor of fat intake, with high averages; followed by industrialized food ingredients (group 2), prepared fish, and other mixed prepared foods (group 1).

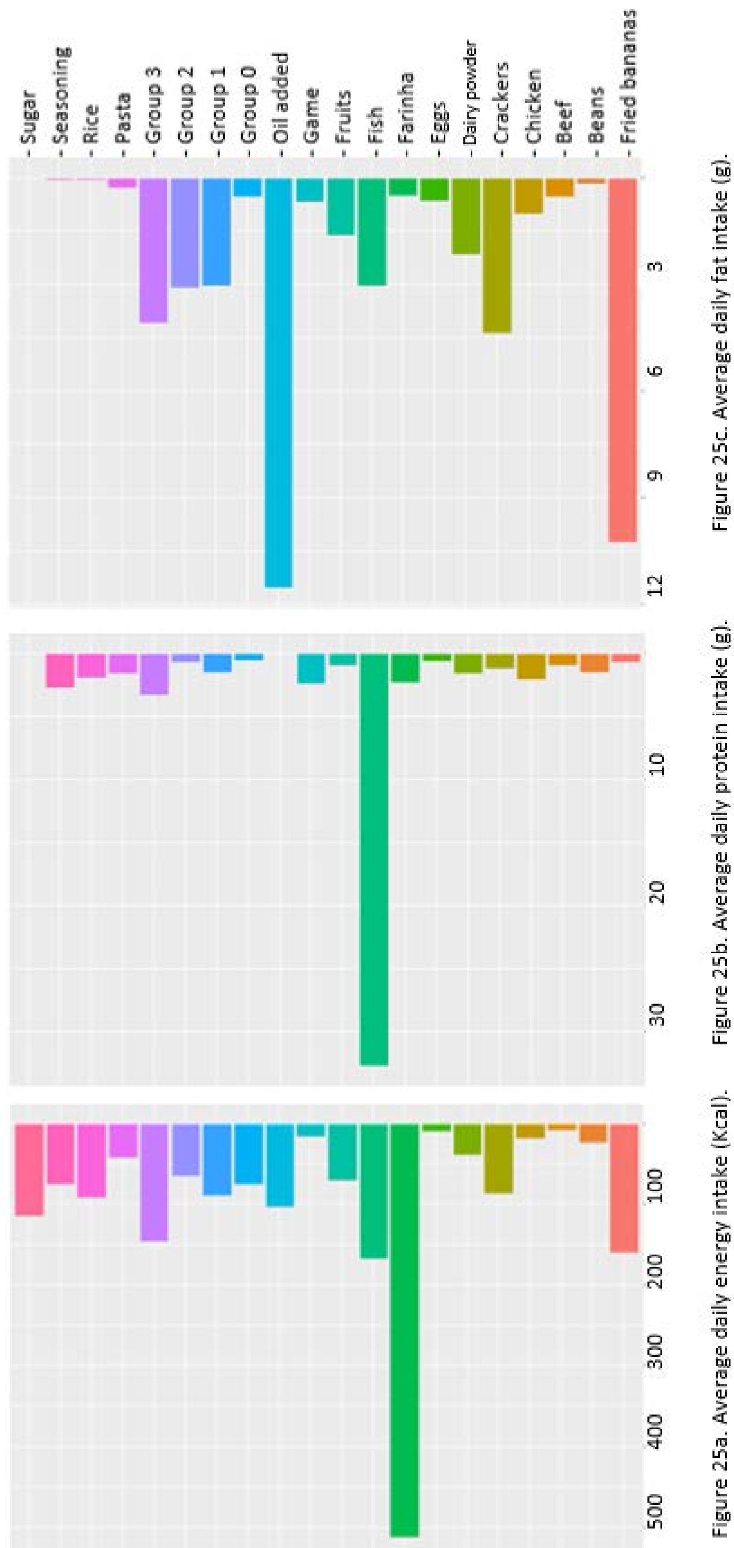


Figure 25. Average daily macronutrient intake by food type from dietary recalls from all participants combined.

The data plotted in Figure 26 shows the sample median (bold line inside each box), the 25th (lower limit of each box), the 75th percentile (upper limit of each box), the sample maximum (end of vertical line at the top of each box), and outliers represented as black dots above the sample maximum line. All figures presented in this chapter with dietary intake compared across seasons use the same representation outlined here.

From an initial descriptive analysis, the median kilocalorie intake and values between the 25th and 75th percentiles (boxes) for food categories appear lower in the rainy season, compared to most median values in other seasons (Figure 26b). Farinha continues to stand out as the main source of energy across seasons, whereas there seems to be some variation among the second largest contributors to kilocalorie intake. The most noticeable differences comparing across seasons are the lower intake of kilocalories from fried bananas and vegetable oil added to dishes in the rainy season, compared to the dry season. Kilocalories from fruits also seem slightly lower in the rainy and dry seasons, compared to the transition season.

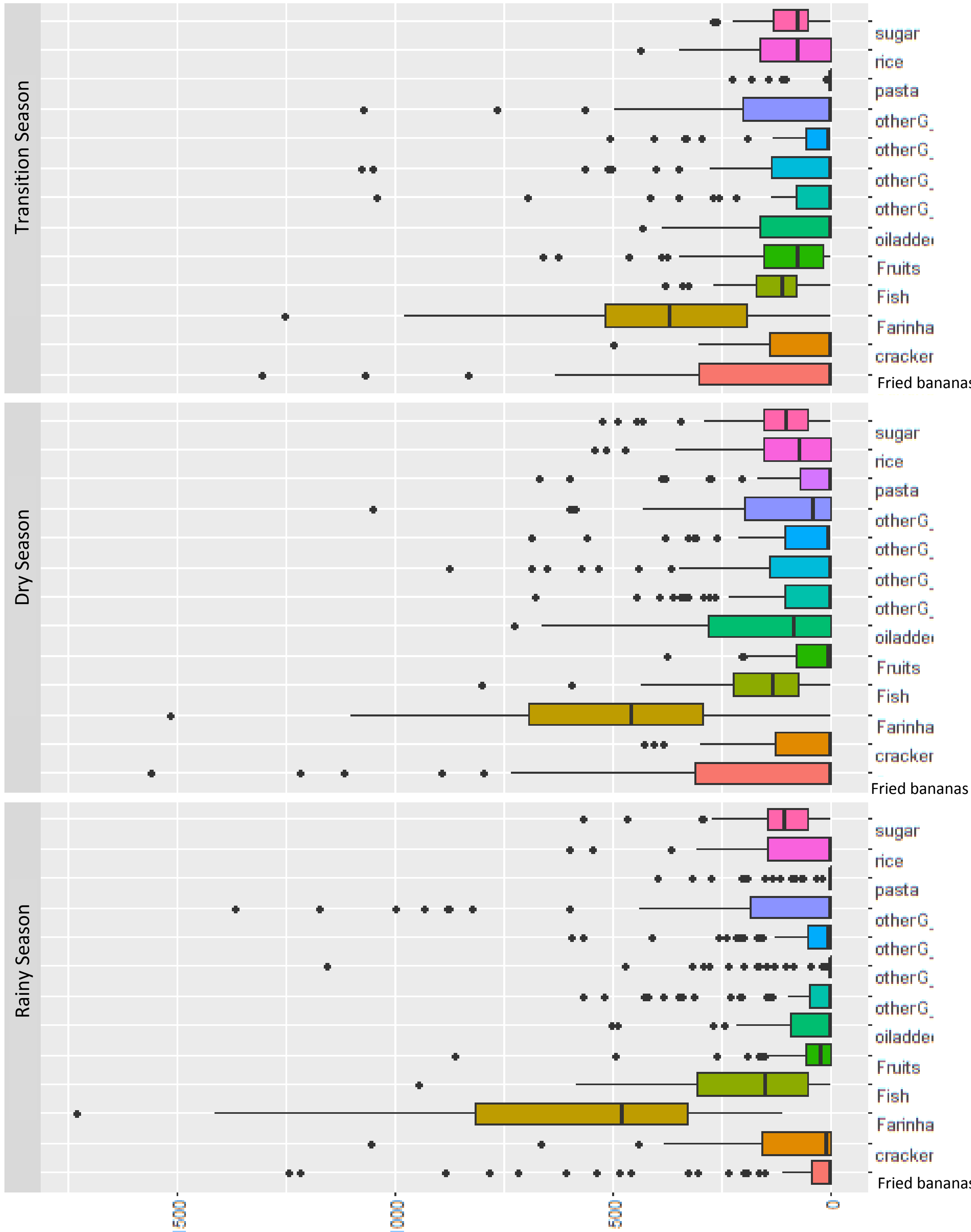


Figure 26a. Daily energy intake (Kcal) across seasons.

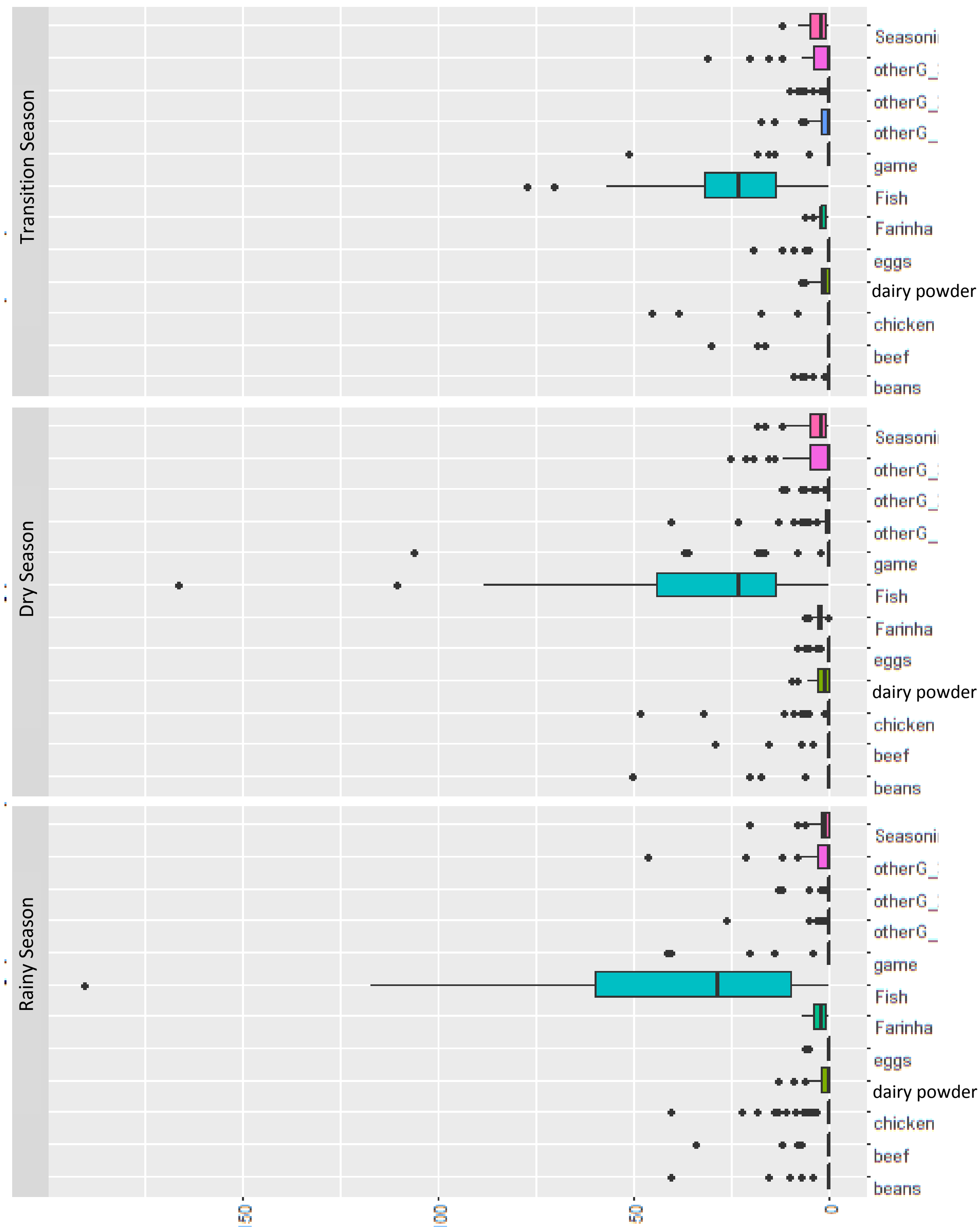


Figure 26b. Daily protein intake (g) across seasons.

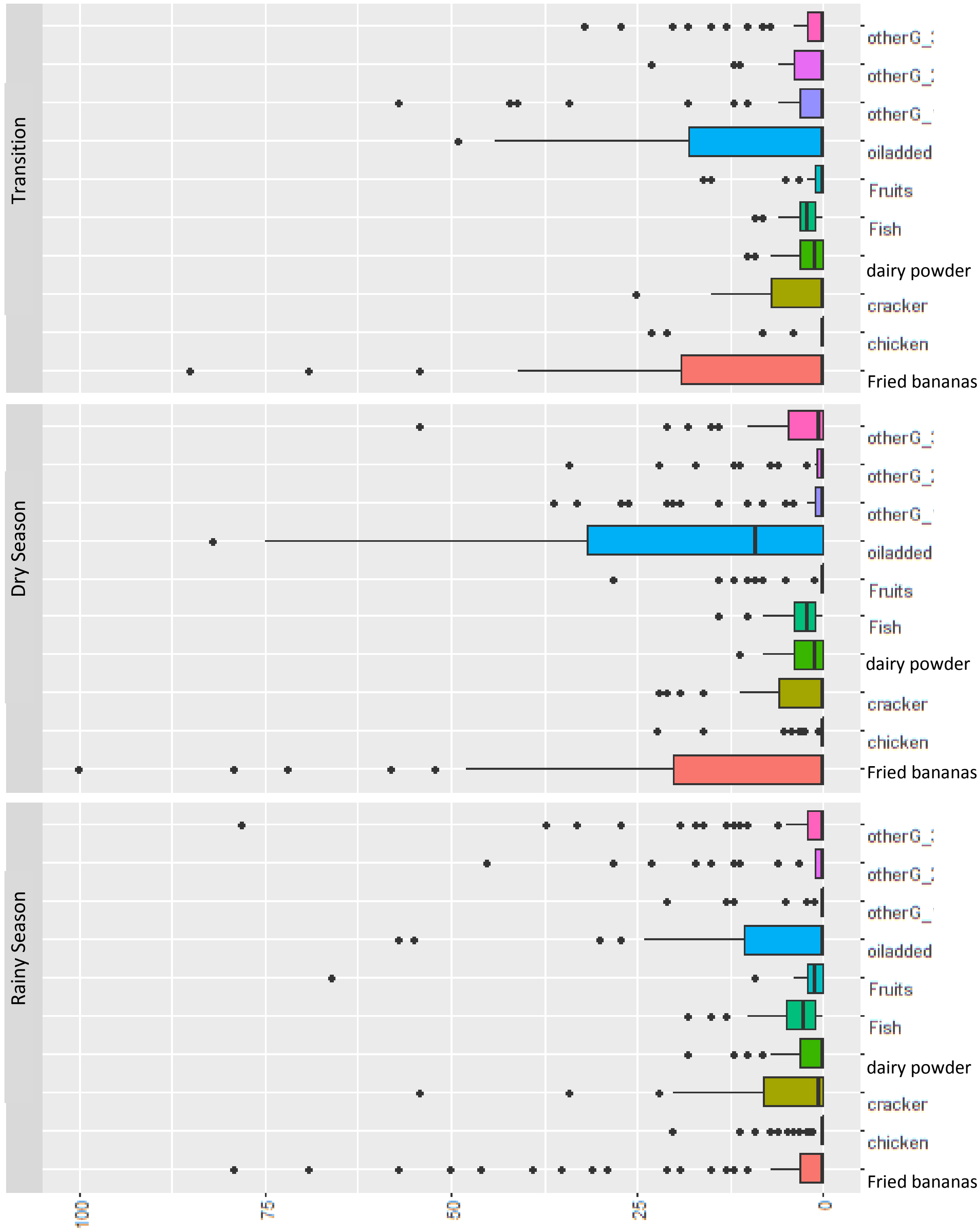


Figure 26c. Daily fat intake (g) across seasons.

Figure 26. Daily macronutrient intake (Kcal, grams of protein, and grams of fat) by season and by selected food types for all participants.

The pattern of prepared fish dominance as a source of protein was also confirmed across seasons, considering diets of typical days for all participants combined (Figure 26b). The median protein daily intake from fish across seasons is similar, but appear slightly higher in the rainy season. Third quartile and maximum values of daily protein intake from fish in the rainy season are visibly higher compared to other seasons. Protein daily intake from food categories other than fish seem small and heterogeneous, with most values computed as outliers.

Logically, differences across seasons in fat intake mirror those of kilocalorie intake, in which daily fat intake from fried bananas and vegetable oil added to dishes are higher in the dry season compared to the rainy season (Figure 26c). There are also significant and consistent levels of daily fat intake from crackers independent of the season.

Macronutrient intake for mothers and adolescents

MOTHERS INTAKE

The 24-hour recalls conducted with adult women showed an average energy intake of 1752 Kcal with considerable variations between recalls, given that the standard deviation represents more than 40% of the average value (Table 3). The average protein consumption was 56.6g. Variation among individual recalls was 52% of the average calculated intake value.

Table 3. Adult women intake per 24-hour dietary recall for all seasons (18 women, 83 recalls).

	Max.	**Min**	**Mean ± SD**	**% of total Kcal intake (Atwater)**
Total (Kcal)	3604	557	1752 ± 735.9	
Carbohydrate (g)	589	85	287.5 ± 124.4	65.6
Protein (g)	175	14	56.5 ± 29.4	12.9
Fat (g)	132	3	42 ± 29.2	21.6

The average caloric intake for women was under the recommended levels, average values were 76.7% and 87.7% for the rainy and dry season respectively. The average protein intake was higher than recommended safe levels, 139%, 149%, and 118.5% respectively for the rainy, dry and transition seasons (Table 4).

Table 4. Adult women dietary intake by season.

	Rainy season (May 2014)		**Dry season (September 2014)**		**Transition season (January 2015)**	
	Mean ± SD	*% (Kcal Intake)*	*Mean ± SD*	*% (Kcal Intake)*	*Mean ± SD*	*% (Kcal Intake)*
Total (Kcal)	1573 ± 680.7		1974 ± 817		1715.6 ± 634.6	
Carbs (g)	261.2 ± 116	66.7	316.1 ± 134.9	63.9	287.8 ± 117.6	66.8
Protein (g)	57 ± 31.2	14.5	61.1 ± 34.3	12.4	48.6 ± 14.6	11.3
Fat (g)	32.7 ± 25.6	18.8	52.2 ± 35.5	23.7	42 ± 18.6	21.9

Results of the linear mixed models used to test the effect of seasonality on dietary intake show a lower intake of kilocalories, carbohydrates and fat in the rainy season, compared to the dry season. No statistical difference was observed for protein intake across seasons. Dietary intake in the transition season was not statistically different from the rainy or dry season for any of the variables considered (Table 5).

Results from the linear mixed models with adult women are shown below:

- Kilocalorie intake was higher in the dry season compared to the rainy season. Seasonality significantly predicted daily kilocalorie intake, β= 397.01, t(66.13) = 2.73, p < .001, controlling for participant's height.
- Carbohydrate intake was higher in the dry season compared to the rainy season. Seasonality significantly predicted daily carbohydrate intake, β= 55.71, t(59.07) = 2.36, p < .01, controlling for participants' height.
- Fat intake was higher in the dry season compared to the rainy season. Seasonality significantly predicted daily fat intake, β= 18.96, t(64.32) = 2.98, p < .001, controlling for participant's height.

Table 5. Linear mixed model results for adult women.

Fixed Effects	Kilocalories Model	Carbohydrates Model	Protein Model	Fat Model
Constant	-5565.05	-819.91	-113.72	-200.81
	(-1.6)	(-1.23)	(-1.09)	(-1.65)
Dry season	397.01**	55.71*	3.87	19.96**
	(2.73)	(2.36)	(0.52)	(2.98)
Transition season	157	30.78	-8.93	10.5
	(0.92)	(1.11)	(-1.04)	(1.41)
Height	4662.9 .	707.86	111.28	152.3 .
	(2)	(1.63)	(1.64)	(1.92)

t statistics in parenthesis, N=80, 18 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

SOURCES OF FOOD FOR MOTHERS

Table 6. Food item average contributions and average percentage of mothers' total daily intake.

Rainy Season (N= 33 recalls)			**Dry Season (N= 30 recalls)**			**Transition Season (N= 20 recalls)**		
Food items	*Mean (Kcal)*	*% intake*	*Food items*	*Mean (Kcal)*	*% intake*	*Food items*	*Mean (Kcal)*	*% intake*
Farinha	535.2	34.0%	Farinha	528.8	27.0%	Farinha	448.8	26.2%
Fish	197.2	12.5%	Fried bananas	211.0	10.8%	Fried bananas	188.3	11.0%
Other group 0 foods	91.5	5.8%	Fish	160.8	8.2%	Other group 1 foods	139.6	8.1%
Rice	90.5	5.8%	Oil added	135.3	6.9%	Fish	135.1	7.9%
Fried bananas	90.5	5.8%	Sugar	134.7	6.9%	Sugar	114.8	6.7%
Sugar	84.9	5.4%	Seasoning	105.5	5.4%	Rice	95.4	5.6%
Seasoning	67.2	4.3%	Other group 0 foods	103.9	5.3%	Other group 0 foods	94.7	5.5%
Other group 3 foods	66.1	4.2%	Rice	103.1	5.3%	Fruits	89.5	5.2%
Cracker	63.5	4.0%	Other group 1 foods	86.2	4.4%	Seasoning	67.5	3.9%
Other group 3 foods	57.9	3.7%	Other group 2 foods	64.7	3.3%	Other group 3 foods	63.3	3.7%
Oil added	57.0	3.6%	Other group 3 foods	60.6	3.1%	Cracker	59.6	3.5%
Other group 1 foods	38.3	2.4%	Cracker	55.6	2.8%	Oil added	53.7	3.1%
Dairy powder	37.7	2.4%	Pasta	51.5	2.6%	Other group 2 foods	48.8	2.8%
Fruits	31.2	2.0%	Beans	47.2	2.4%	Dairy powder	47.5	2.8%
Pasta	29.5	1.9%	Dairy powder	40.4	2.1%	Beans	18.4	1.1%
Chicken	21.0	1.3%	Fruits	31.4	1.6%	Beef	16.1	0.9%
Game	10.9	0.7%	Game	18.5	0.9%	Game	14.2	0.8%
Eggs	2.7	0.2%	Beef	9.3	0.5%	Eggs	11.7	0.7%
Beans	0	0%	Eggs	5.3	0.3%	Pasta	5.4	0.3%
Beef	0	0%	Chicken	2.9	0.1%	Chicken	3.7	0.2%
Total Kcal	1573			1957			1715.6	

Food sources of kilocalories in mother's diets

The main source of kilocalorie intake, independent of seasons, was farinha. After farinha, prepared fish, fried bananas, and sugar were among the main contributors (Figure 27).

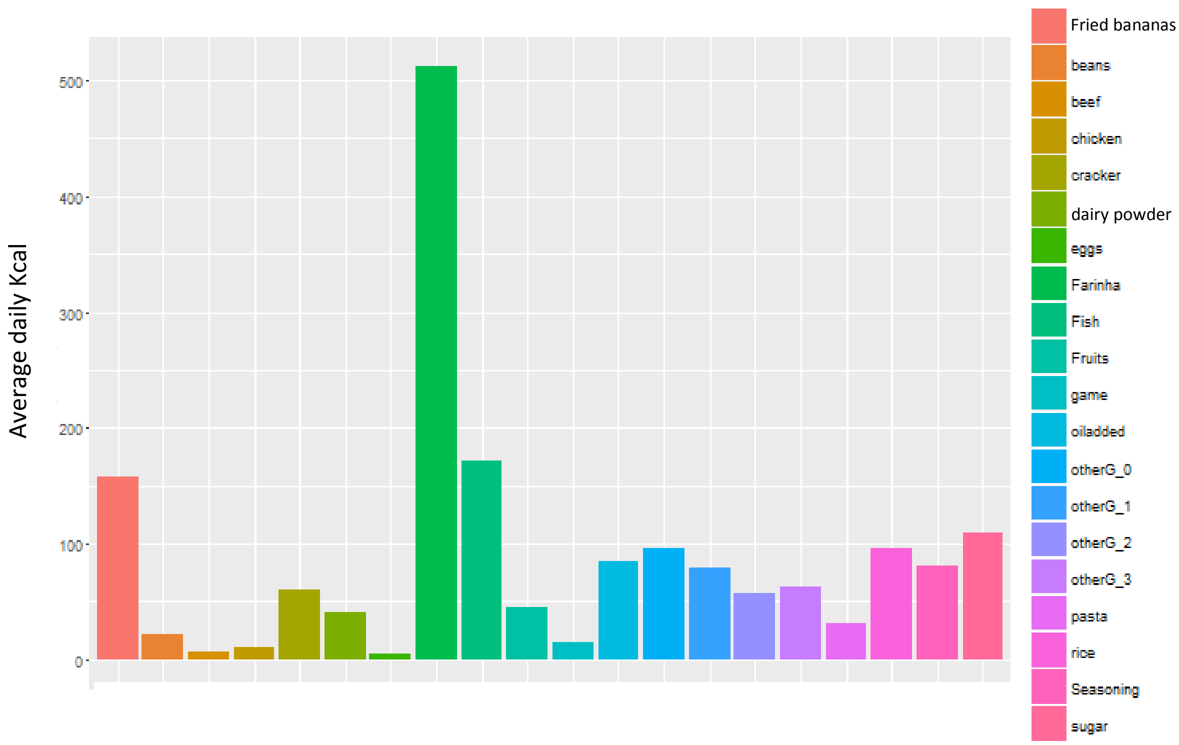


Figure 27. Average daily Kcal intake by food type for mothers (all seasons combined).

Farinha contributed with more than 25% of daily calories on average in all seasons, and most kilocalories were consumed from farinha, compared to other food items, independent of the season. On the other hand, prepared fish contributed with more than 10% of the kilocalories in the rainy season. Mothers consumed more kilocalories from fried bananas compared to prepared fish both in the dry and transition season (Table 6).

Considering each food type, the linear mixed model below was used to estimate the effect of seasons on kilocalorie amounts by food type:

*Log daily kilocalorie intake = season + food type + season*food type + (1|id)* [f]

The model estimates for interaction between seasons are reported in Table 7, and Table 8 summarizes the results of the model. There was a significantly higher caloric intake from fried bananas in the dry season compared to the rainy season. On average women consumed 56.4% more kilocalories from fried bananas in the dry season compared to the rainy season.

Table 7. LMM results for selected energy rich foods[g] in adult women dietary recalls.

Fixed Effects Model	Rainy Season	Dry Season		Transition Season	
		Estimate	%Δ	*Estimate*	%Δ
Farinha	Ref.	6.08 (-1.86) .	-8.37	5.96 (-1.42)	-18.84
Fish	Ref.	4.88 (-2.19)*	-23.01	4.75 (-1.77)	-32.55
Fried bananas	Ref.	5.97 (ref)***	56.43	5.67 (ref)	41.27
Seasoning	Ref.	4.56 (-0.22)	51.11	3.82 (-1.06)	-2.87
Other group 0 foods	Ref.	5 (-0.53)	41.40	3.55 (-2.48)	59.92
Rice	Ref.	4.97 (-1.71) .	-12.39	4.94 (-1.16)	-14.43
Other group 3 foods	Ref.	4.44 (-1.09)	18.68	4.61 (-0.24)	31.61
Sugar	Ref.	4.69 (-1.05)	26.54	4.67 (-0.46)	25.28
Oil added	Ref.	5.18 (-0.76)	33.17	4.87 (-0.69)	9.60
Dairy powder	Ref.	**4.13** **(-1.74) .**	**-13.72**	4.17 (-1.1)	-10.85
Chicken	Ref.	**3.25** **(-2.13) ***	**- 68.03**	5.09 (0.13)	49.85

Interaction t statistics in parenthesis, N=80, 18 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

[f] (1|id) assumes random effects by participant, meaning that the model adopts different intercepts for each participant, accounting for repeated recalls with the same participants.

[g] Based on the daily average contribution of Kcal of a particular food category per day as presented in *Figure 27*.

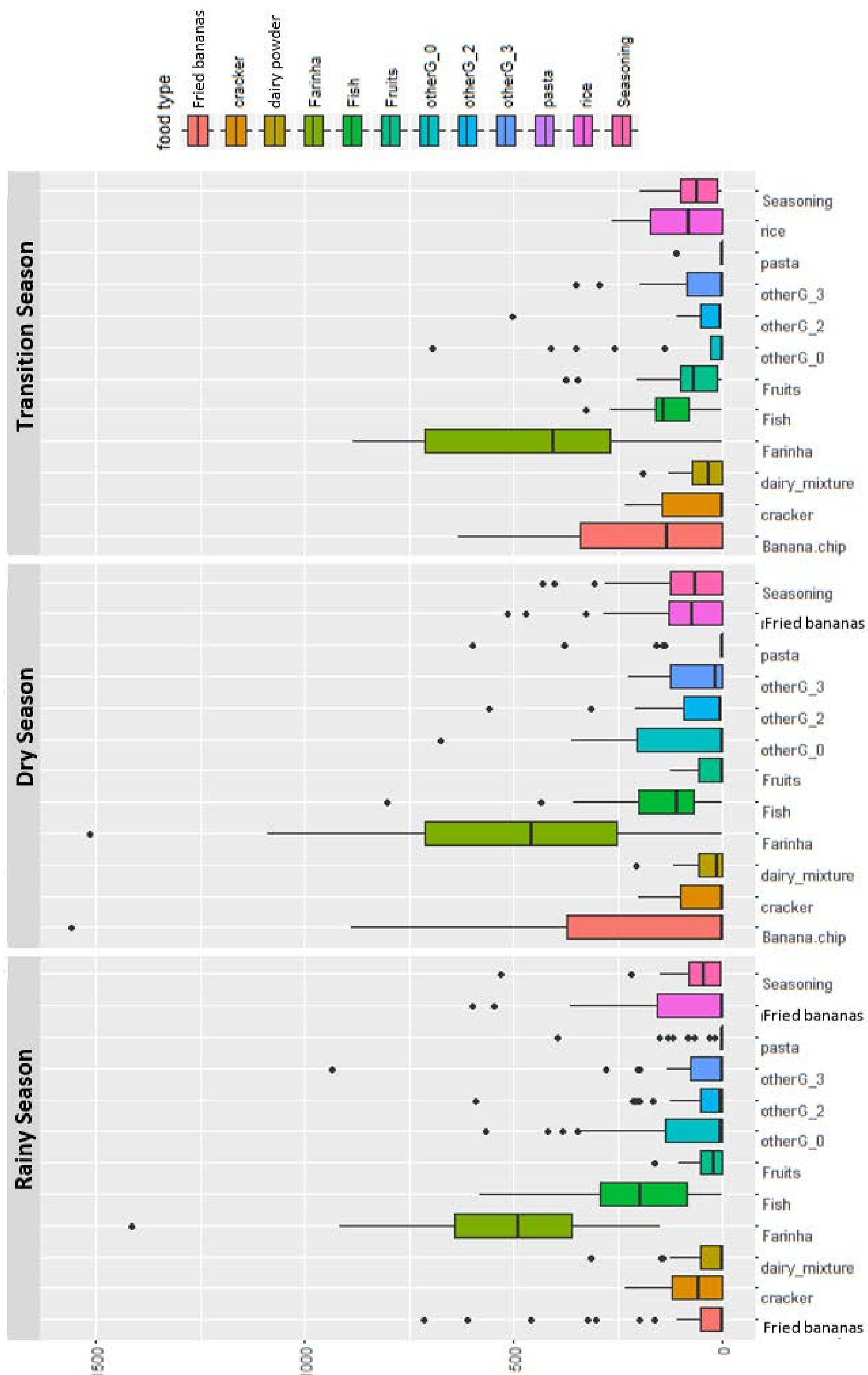


Figure 28. Sum of energy contribution (Kcal) from selected kilocalorie rich food types across seasons.

Table 8. Summary of differences in daily caloric contribution of foods across seasons.

Average daily kilocalorie intake	**Compared to dry season**
Higher in rainy season	Farinha (8.4%), fish (23%), rice (12.4%), dairy powder (13.7%)*, and chicken (68%)*
Higher in dry season	Fried bananas (56%)
No significant difference	Sugar, oil in addition, other G1 foods, seasonings, other G0 foods, pasta, fruits, other G3 foods*, other G2 foods*, beans*, crackers*, game*, beef*, eggs*

*Lower than 5% of total kilocalorie contribution per season

Despite the higher average kilocalorie consumption in the dry season, five food items were in fact significantly contributing less with kilocalories on average compared to the rainy season. These were the two main staple foods, farinha and fish, as well as rice, chicken and dairy powder (Table 7). In the dry season, on average, women consumed: 8.4 % less kilocalories from farinha, 23% less kilocalories from prepared fish, 12.4% less kilocalories from rice, and 68% less kilocalories from chicken. Chicken consumption is infrequent and represents a low kilocalorie contribution compared to other protein sources (6 recalls in the rainy season, 2 in the dry season, and 1 in the transition season). Similarly, dairy powder has a relatively low kilocalorie contribution in general (less than 3% of the total intake (Table 6), even though a significant difference in kilocalorie amount across seasons was observed. No significant difference in kilocalories consumption between the rainy and dry season was observed for any of the other food items; and kilocalories consumption between the transition season and other seasons was not significant.

In sum, for adult women, farinha and fish (including fried preparations) contributed a higher average number of kilocalories in the rainy compared to the dry season (Table 7). However, the highest amounts of kilocalories are consumed in the dry season (Table 4). While women seem to be relying more heavily on farinha and fish staples as sources of energy in the rainy season, the higher caloric intake in the dry season is accounted for mainly by a higher consumption of fried bananas.

Food sources of protein in mother's diets

In terms of protein intake for adult women, fish is the most significant protein rich food in diets compared to all other sources, independent of the season (Figure 29, Table 9).

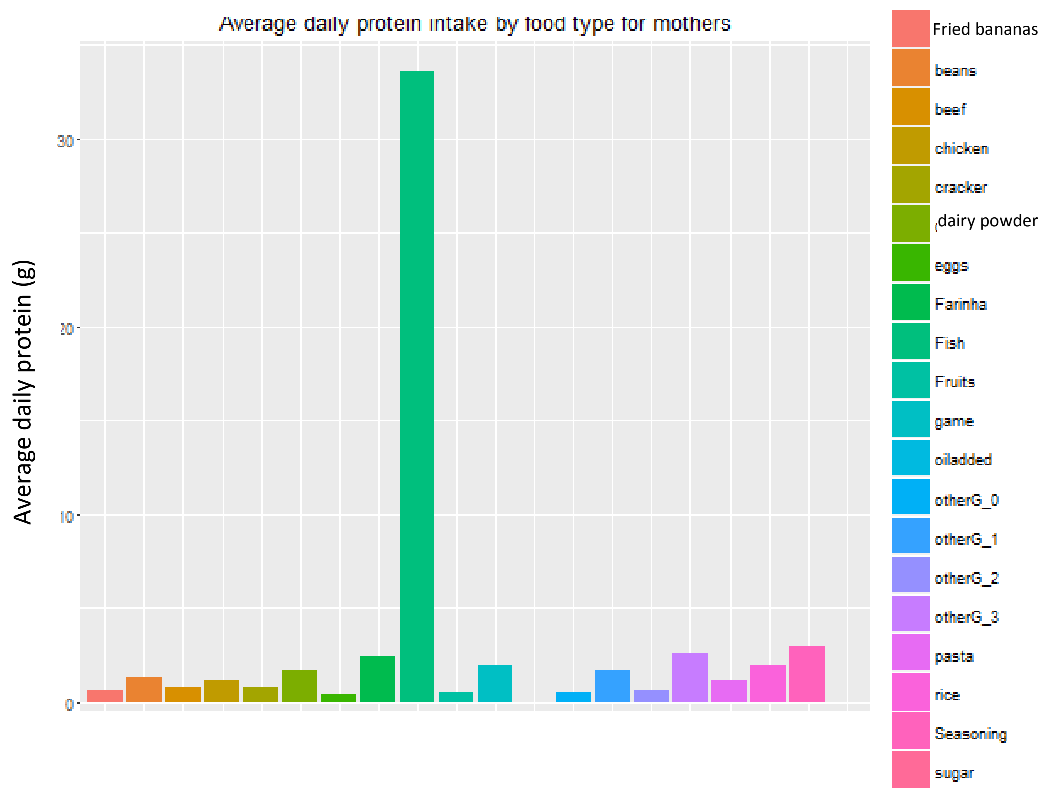


Figure 29. Average protein intake (grams/day) by food type/category for mothers.

Table 9. Food item average contributions and average percentage of total protein intake.

Rainy Season (N= 33 recalls)			**Dry Season (N= 30 recalls)**			**Transition Season (N= 20 recalls)**		
Food items (g)	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*
Fish	38.39	67.4%	Fish	32.13	52.6%	Fish	26.10	53.7%
Farinha	2.58	4.5%	Other group 3 foods	3.23	5.3%	Other group 3 foods	2.10	4.3%
Other group 3 foods	2.39	4.2%	Other group 1 foods	3.13	5.1%	Farinha	2.05	4.2%
Chicken	2.35	4.1%	Beans	3.00	4.9%	Other group 1 foods	2.00	4.1%
Game	1.82	3.2%	Farinha	2.47	4.0%	Dairy powder	1.79	3.7%
Dairy powder	1.55	2.7%	Game	2.30	3.8%	Game	1.65	3.4%
Other group 2 foods	0.52	0.9%	Dairy powder	1.79	2.9%	Beef	1.50	3.1%
Other group 1 foods	0.30	0.5%	Beef	1.10	1.8%	Beans	1.20	2.5%
Eggs	0.18	0.3%	Other group 2 foods	0.67	1.1%	Other group 0 foods	1.15	2.4%
Other group 0 foods	0.03	0.1%	Other group 0 foods	0.63	1.0%	Eggs	0.95	2.0%
Beans	0	0.0%	Eggs	0.37	0.6%	Other group 2 foods	0.55	1.1%
Beef	0	0.0%	Chicken	0.33	0.5%	Chicken	0.40	0.8%
All others	6.89	12.1%	All others	9.99	16.14%	All others	7.2	14.7%
Total Kcal	57			61.14			48.64	

Fish contributes with more than 50% of the daily protein intake across seasons, and all other food items or categories accounted for less than 6% of the protein intake across seasons (Table 9). There was no significant difference in the contribution of protein from fish between the rainy and dry season (Table 10).

Considering protein daily intake from each food type the linear mixed model below was used to estimate the effect of seasons by food type:

Log daily protein intake = season + height + (1|id) [h]

The model estimates for fish and other foods of group 3 are reported in Table 10 and Table 11 summarizes the results of the model.

Table 10. LMM for selected protein rich foods [i] in adult women dietary recalls.

Fixed Effects Model	Rainy Season	Dry Season		Transition Season	
		Estimate	%Δ	*Estimate*	%Δ
Fish	Ref.	-0.26 (-1.37)	-22.91	**-0.36 . (-1.68)**	**-30.20**
Other group 3 foods	Ref.	0.17 (0.47)	-15.5	-0.21 (-0.51)	19.01

Interaction t statistics in parenthesis, N=80, 18 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

There was no significant difference in daily protein intake from fish or other foods of group 3 between the rainy and dry season. However, on average women consumed 36% less protein from fish in the transition season compared to the rainy season (p<0.1, Table 10). Using descriptive statistics, considering the average daily intake of protein by food type (Table 9), as well as medians (*Figure 30*), the dry season seems to represent a larger diversity of foods providing protein in women's diets, especially considering the consumption of beans and beef

[h] (1|id) assumes random effects by participant, meaning that the model adopts different intercepts for each participant, accounting for repeated recalls with the same participants.
[i] Based on the daily average contribution of protein of a particular food category per day as presented in *Figure 29*.

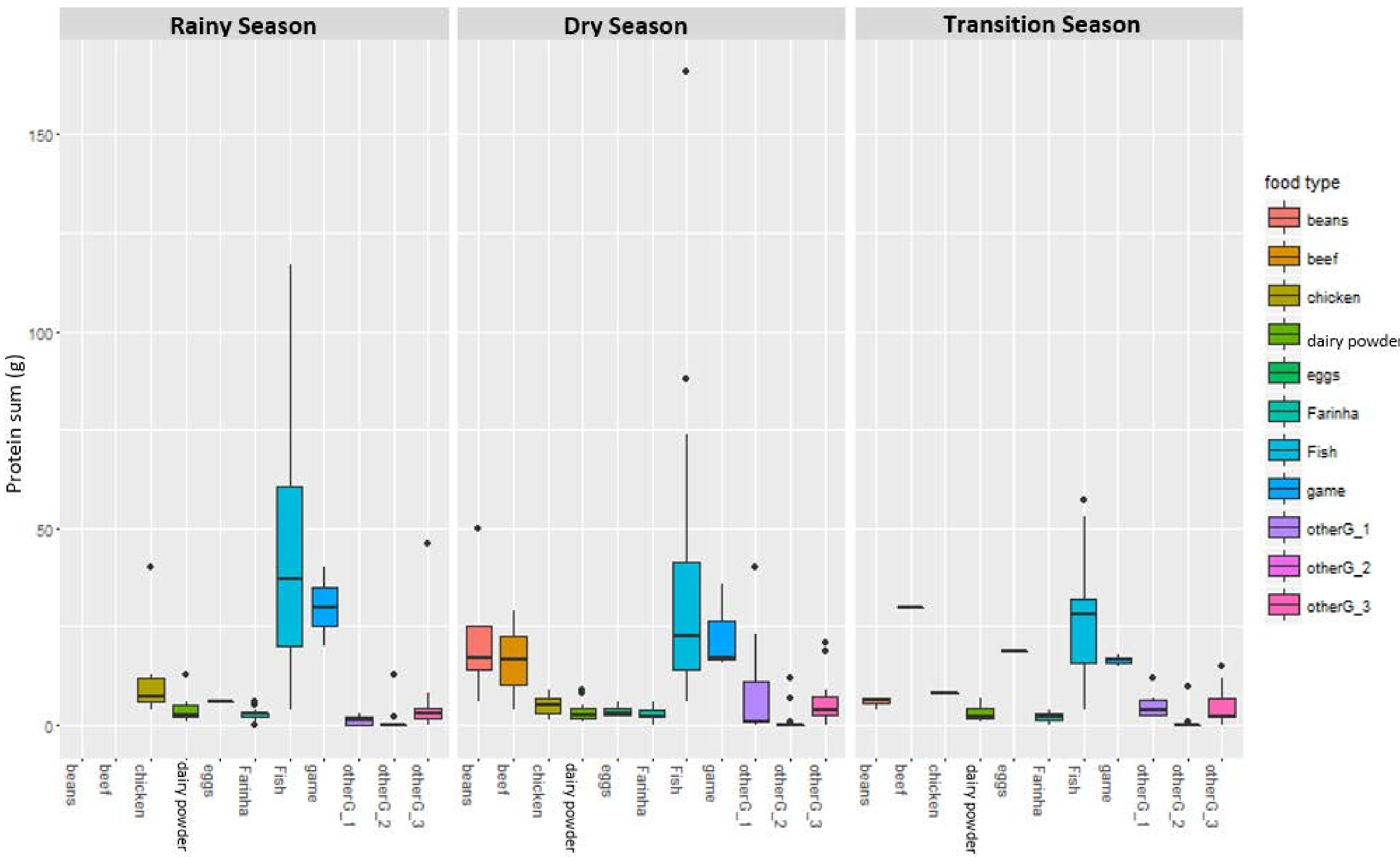
(not reported at all in the rainy season), amounts of protein from mixed prepared foods (group 1), highly industrialized foods (group 3), and the presence of other protein rich foods, even with lower medians for consumption in the rainy season, such as of chicken, game, and eggs (Figure 30).

Table 11. Summary of differences in daily caloric contribution of foods across seasons.

Average daily protein intake	**Compared to dry season**
No difference from rainy season	Fish and other group 3 foods
Excluded from model: no protein or very low protein content foods (or low serving size)	Sugar, vegetable oil, fruits, other group 2 foods, other group 0 foods, farinha, crackers, fried bananas, pasta, rice, seasonings, other group 1 foods, and dairy powder
Excluded from model: protein rich foods with sample size lower than 4 per season	Chicken, eggs, game, beans, and beef

In sum, results show the exceptional importance of fish as a protein source in adult women’s diets across seasons. It is also important to note that the statistically significant caloric difference linked to fish consumption is due to its preparation fried with vegetable oil. Taking into account meals including fish, fish stew was the most frequent preparation (54%), followed by fried fish (34%), and grilled fish (12%). In terms of protein rich food sources, the data suggests a diversification in the dry season (e.g. addition of beans and beef), even though foods other than fish play a minor role.

Figure 30. Daily protein intake (g) per selected food type across seasons.



Food sources of fat in mother's diets

In terms of daily fat intake, the main sources across seasons for mothers were oil added to meat dishes and fried bananas (Figure 31). Both these food items together accounted for almost 40% of the daily total fat intake in the rainy season, and more than 40% in the dry and transition seasons (Table 12).

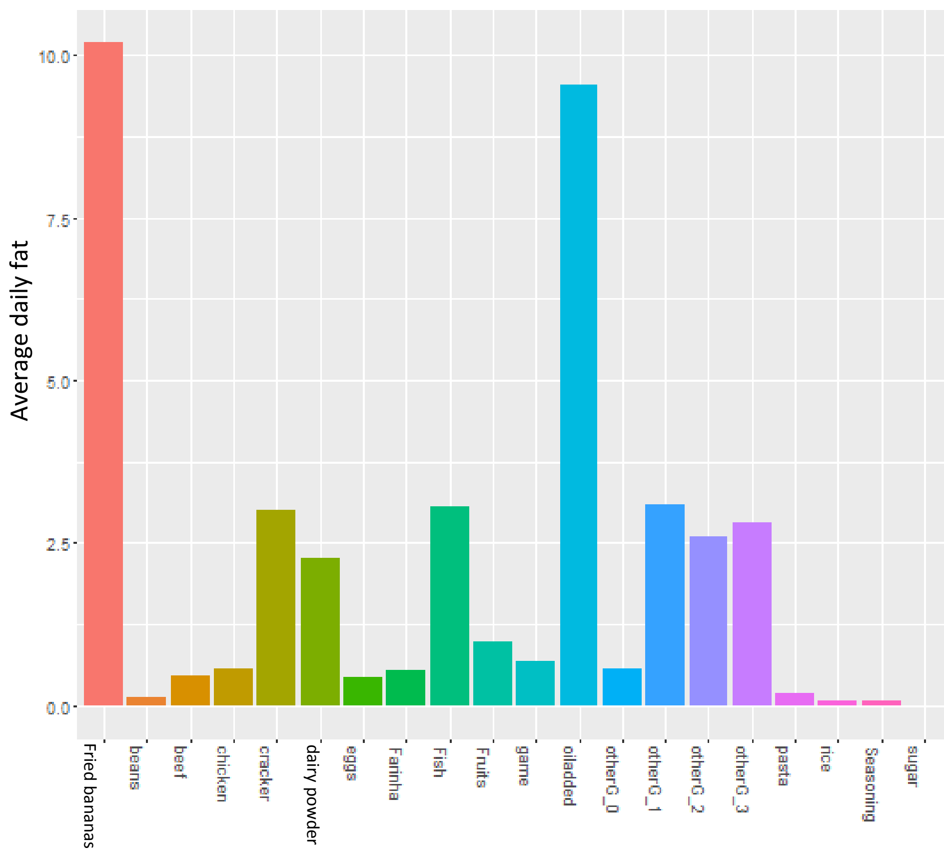


Figure 31. Average daily fat intake (g) by food type for mothers.

Table 12. Food item average contributions and average percentage of total fat intake.

Rainy Season (N= 33 recalls)			**Dry Season (N= 30 recalls)**			**Transition Season (N= 20 recalls)**		
Food items (g)	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*
Oil added	6.45	19.71%	Oil added	15.27	30.40%	Fried bananas	12.25	29.17%
Fried bananas	5.79	17.68%	Fried bananas	13.67	27.22%	Oil added	6.05	14.41%
Fish	3.70	11.29%	Other group 1 foods	3.57	7.10%	Other group 1 foods	5.60	13.34%
Other group 3 foods	3.24	9.90%	Other group 2 foods	2.90	5.78%	Other group 3 foods	3.10	7.38%
Cracker	3.21	9.81%	Cracker	2.77	5.51%	Cracker	3.05	7.26%
Other group 2 foods	2.76	8.42%	Fish	2.53	5.05%	Fish	2.65	6.31%
Dairy powder	2.09	6.39%	Dairy powder	2.26	4.50%	Dairy powder	2.54	6.05%
Chicken	1.20	3.65%	Other group 3 foods	2.13	4.25%	Other group 2 foods	1.90	4.52%
Fruits	1.12	3.42%	Fruits	1.17	2.32%	Beef	1.10	2.62%
Other group 1 foods	1.12	3.42%	Game	0.97	1.93%	Game	0.80	1.91%
Farinha	0.58	1.76%	Farinha	0.60	1.19%	Eggs	0.80	1.91%
Other group 0 foods	0.58	1.76%	Beef	0.53	1.06%	Other group 0 foods	0.80	29.17%
All others	0.91	2.78%	All others	1.85	3.69%	All others	1.35	3.21%
Total Kcal	32.74			50.22			41.99	

Considering each food type, the linear mixed model below was used to estimate the effect of seasons on kilocalorie amounts by food type:

Log daily fat intake (specific food item/category) = season + (1|id) [j]

The model estimates for each model are reported in Table 7, and Table 8 summarizes the results of the model. There was a significantly higher fat intake from fried bananas and mixed processed foods (group 1) in the dry season compared to the rainy season. On average women were consuming 120.34% more fat from fried bananas and 182.92% more fat from mixed processed foods (group 1) in the dry season, compared to the rainy season (Table 13).

Table 13. Linear mixed model results for selected fat rich foods [k] in adult women dietary recalls.

Fixed Effects Model	Rainy Season	Dry Season		Transition Season	
		Estimate	%Δ	*Estimate*	%Δ
Oil added to dishes	Ref.	0.44 (1.68)	55.27	-0.03 (-0.09)	-2.96
Fried bananas	Ref.	0.79 (2.41)*	**120.34**	0.49 (1.47)	63.23
Fish	Ref.	-0.31 (-2.06)*	**-26.66**	-0.27 (-1.61)	-23.66
Other group 3 foods	Ref.	0 (0)	0.30	-0.04 (-0.08)	-3.92
Other group 1 foods	Ref.	1.04 (2.31)*	**182.92**	0.95 (2) .	**158.57**
Crackers	Ref.	0.03 (0.26)	3.05	0.17 (1.18)	18.53

t statistics of each model in parenthesis, N=80, 18 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

There was no significant difference in the consumption of oil added to prepared meats, other group 3 foods, and crackers, comparing fat intake between the rainy and dry season. Fat intake from group 1 foods was also higher in the transition seasons compared to the rainy

[j] (1|id) assumes random effects by participant, meaning that the model adopts different intercepts for each participant, accounting for repeated recalls with the same participants.
[k] Based on the daily average grams contribution of fat of a particular food category per day as presented in *Figure 31*Figure 27.

season, while there were no differences for the other food types considered. Table 14 summarizes the results.

Table 14. Summary of differences in daily fat contribution of foods across seasons.

Average daily fat intake	**Compared to dry season***
Higher in rainy season	Fish (26.6%)
Lower in rainy season	Fried bananas (120.34%), mixed processed foods (group 1) (182.92%)
No difference from rainy season	Oil added to dishes, other group 3 foods, and crackers
Excluded from model: no fat, very low fat content foods, or low serving size	Sugar, seasonings, rice, other group 2 foods, other group 0 foods, farinha, fruits, pasta, rice, and dairy powder
Excluded from model: sample size lower than 4 recalls in each season	Chicken, eggs, game, beans, and beef

Despite the higher average fat consumption in the dry season, fish contributed less with daily fat intake, compared to the rainy season. In the dry season, on average, women consumed 26.9% less fat from fish (preparation included fried and grilled fish).

In sum, for adult women, the higher daily fat intake observed in the dry season is mainly accounted for by the higher consumption of fried bananas, and by a higher consumption of mixed processed foods (group 1). Moreover, there is less fat coming from fish intake in the dry season, which is again linked to preparation of fried fish. Overall, results show more diverse sources of protein, and a higher kilocalorie consumption in the dry season. The main contributor for this difference, which is also reflected in daily fat intake, is fried bananas.

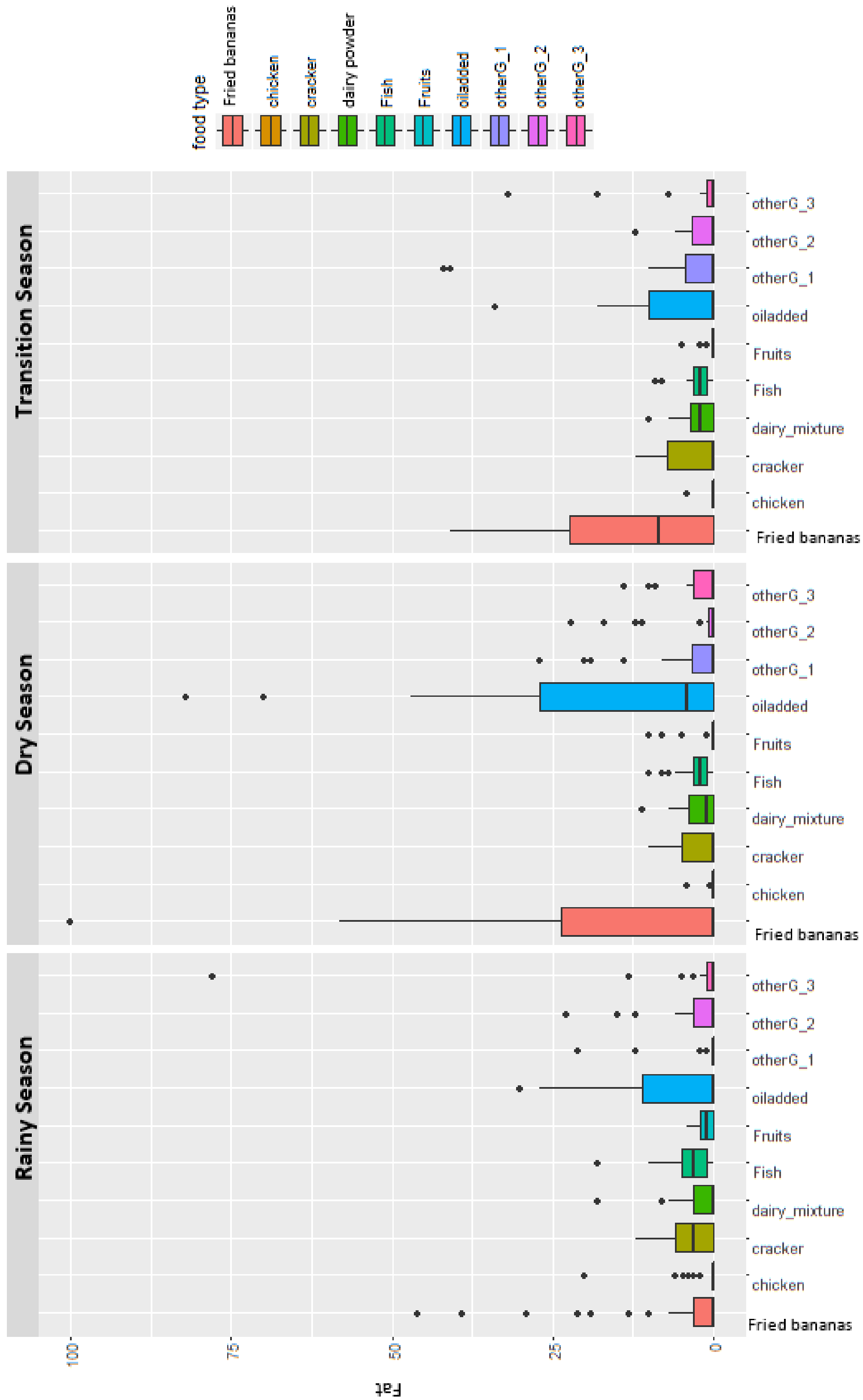


Figure 32. Daily fat contribution (g) from selected food types across seasons.

In the rainy season, however, even though kilocalorie consumption is lower, people are consuming more fried fish and chicken. In terms of protein, fish is the main source across seasons, and no significant difference in daily intake was observed.

FEMALE ADOLESCENTS INTAKE

The 24-hour recalls conducted with adolescent females showed an average energy intake of 1812 Kcal with considerable variations between recalls, given that the standard deviation represents more than 48% of the average value (Table 15). The average protein consumption was 53.7g, and the variation among individual recalls for protein was high, 55% of the average calculated intake value.

Table 15. Adolescent female dietary intake for all seasons.

	Max.	**Min**	**Mean ± SD**	**% of total Kcal Intake (Atwater)**
Total (Kcal)	4100	620	1812 ± 884.6	63.3
Carbohydrate (g)	578.8	73	287.7 ± 144.9	11.8
Protein (g)	135.2	10.56	53.7 ± 29.4	24.9
Fat (g)	140.2	2	50.3 ± 35.3	

The average kilocalorie intake for female adolescents was under the FAO/WHO/ONU (1985) recommended levels. Values were 82.1%, 97.4% and 92.9% for the rainy, dry, and transition season respectively.

Table 16. Adolescent female dietary intake by season.

	Rainy season (May 2014)		**Dry season (September 2014)**		**Transition season (January 2015)**	
	Mean ± SD	*% (Kcal Intake)*	*Mean ± SD*	*% (Kcal Intake)*	*Mean ± SD*	*% (Kcal Intake)*
Total (Kcal)	1665 ± 874		1974 ± 817		1884 ± 967.3	
Carbs (g)	275 ± 152.7	66.4	282.6 ± 119.1	59.2	307.5 ± 167.3	64.6
Protein (g)	54.5 ± 33.4	13.2	55.6 ± 33.9	11.7	50.6 ± 19.5	10.6
Fat (g)	37.7 ± 25	20.5	61.8 ± 39.6*	29.1	52.4 ± 38	24.8

The average protein intake was higher than recommended safe levels, 123.9%, 126.4%, and 115% respectively for the rainy, dry and transition seasons (Table 16).

The results of the linear mixed models for adolescent females, used to test the effect of seasonality on dietary intake, are presented below. Results shows a lower intake of fat in the rainy season, compared to the dry season. No statistical difference was observed for all other dietary variables among seasons (Table 17).

Table 17. Linear mixed model results for adolescent females.

Fixed Effects	**Kilocalories Model**	**Carbohydrates Model**	**Protein Model**	**Fat Model**
Constant	214.9	2889.48	-18.65	308.42
	(0.17)	(0.37)	(-0.09)	(1.22)
Dry season	9.75	220.44	0.61	**24.36***
	(0.32)	(1.16)	(0.06)	(2.56)
Transition season	23.11	168.36	-5.51	15.44
	(0.71)	(0.82)	(-0.56)	(1.53)
Height	62.81	-659.92	51.25	-177.33
	(0.07)	(-0.13)	(0.39)	(-1.04)

t statistics in parenthesis, N=48, 10 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Results from the linear mixed models with adolescent females are listed below:

- There was no significant difference in daily caloric intake between seasons, β= 220.44, t(189.9) = 1.61, p=0.25, controlling for participants' height;
- There was no significant difference in daily carbohydrate intake between seasons, β= 9.7, t(30.1) = 0.32, p=0.7, controlling for participants' height;
- There was no significant difference in daily protein intake between seasons, β= 0.6, t(9.4) = 0.06, p=0.94, controlling for participants' height;
- Fat intake was higher in the dry season compared to the rainy season. Seasonality significantly predicted daily fat intake, β= 24.36, t(9.5) = 2.6, p < .01, controlling for participant's height.

SOURCES OF FOOD FOR ADOLESCENT FEMALES

In order to understand the dietary changes related to the statistical differences observed above, I investigated how much the main food items or categories contribute to energy intake, protein, and fat in individual recalls in each season, for the adolescent female sample. The analysis was conducted along the same lines as previously done for mother's dietary recall data.

Food sources of kilocalories in adolescent female's diets

Just as observed for mothers, the main source of kilocalorie intake across seasons was farinha. After farinha, however, the highest food categories contributing to kilocalorie intake were highly industrialized foods (group 3) followed by fried bananas and prepared fish (Figure 33). The most noticeable difference in female adolescent's diets compared to mothers is the higher kilocalorie contribution from highly industrialized foods and lower contribution of prepared fish in the rainy season.

The average percentage of kilocalorie contribution to diets varied across seasons, for the second and third most important food items, including highly industrialized foods (group 3), fried bananas, prepared fish and vegetable oil (Table 18). Farinha contributed with more than 15% of the daily calories on average for all seasons, less than the observed amount for women. The kilocalorie contribution of each categorized food item was calculated based on the percentage of contribution in each food recall per season (Table 18). This ranking of importance informed the analysis of the effects of season on the consumption of specific food items.

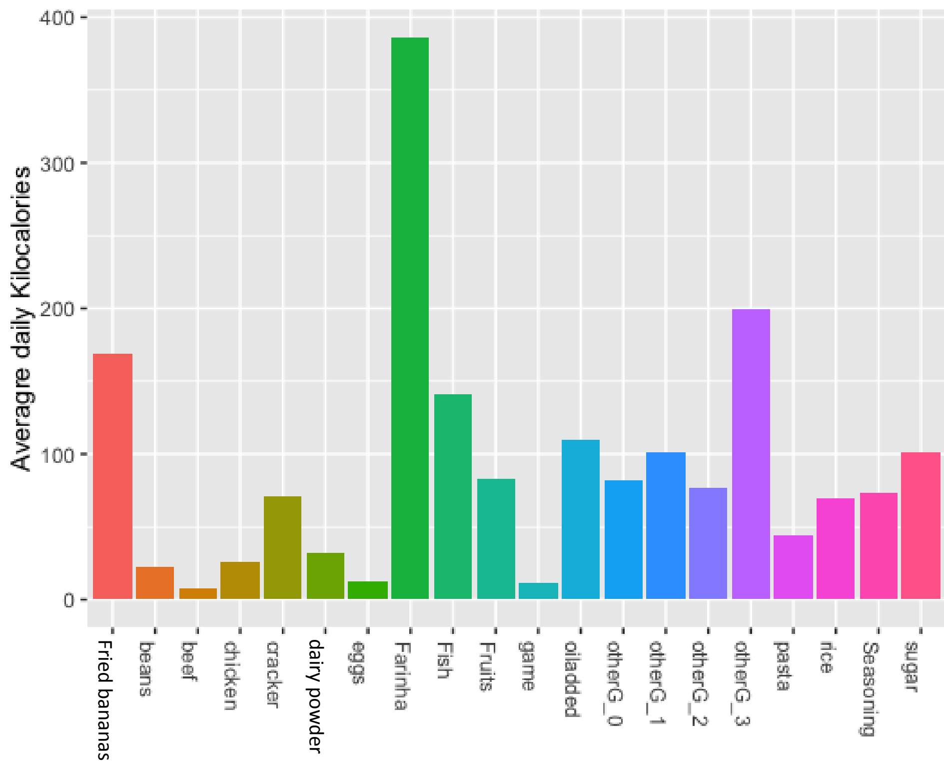


Figure 33. Average daily caloric intake by food type for adolescent females.

Table 18. Food item average contributions and average percentage of total intake (female adolescent recalls).

Rainy Season (N= 17 recalls)			**Dry Season (N= 16 recalls)**			**Transition Season (N= 15 recalls)**		
Food items (Kcal)	*Mean*	*% intake*	*Food item (Kcal)*	*Mean*	*% intake*	*Food item (Kcal)*	*Mean*	*% intake*
Farinha	475.6	28.6%	Farinha	321.4	16.9%	Farinha	354.9	18.8%
Other group 3 foods	252.8	15.2%	Fried bananas	252.8	13.3%	Fried bananas	242.9	12.9%
Fish	185.8	11.2%	Oil added	177.9	9.4%	Other group 3 foods	198.5	10.5%
Sugar	117.0	7.0%	Other group 3 foods	142.6	7.5%	Fruits	164.1	8.7%
Cracker	116.0	7.0%	Fish	132.1	7.0%	Other group 1 foods	159.9	8.5%
Oil added	85.4	5.1%	Other group 1 foods	108.5	5.7%	Fish	98.9	5.3%
Other group 2 foods	75.5	4.5%	Sugar	104.1	5.5%	Other group 0 foods	98	5.2%
Other group 0 foods	49.3	3.0%	Other group 0 foods	101.2	5.3%	Rice	82.4	4.4%
Rice	46.6	2.8%	Seasoning	89.5	4.7%	Sugar	79.6	4.2%
Seasoning	45.1	2.7%	Other group 2 foods	83.7	4.4%	Seasoning	72.1	3.8%
Beans	42.9	2.6%	Fruits	79.5	4.2%	Other group 2 foods	71.4	3.8%
Other group 1 foods	42.3	2.5%	Cracker	67.1	3.5%	Oil added	65.9	3.5%
Fruits	34.2	2.1%	Dairy Powder	58.5	3.1%	Cracker	48.5	2.6%
Dairy Powder	31.4	1.9%	Beans	44.6	2.3%	Pasta	36.2	1.9%
Pasta	18.8	1.1%	Dairy powder	40.6	2.1%	Chicken	34.3	1.8%
Fried bananas	14.3	0.9%	Chicken	29.9	1.6%	Eggs	31.5	1.7%
Chicken	13.7	0.8%	Game	24.8	1.3%	Dairy Powder	22.2	1.2%
Eggs	9.3	0.6%	Beans	19.9	1.0%	Game	10.6	0.6%
Beef	8.8	0.5%	Beef	4.1	0.2%	Beef	10.5	0.6%
Game	0	0%	Eggs	0	0%	Beans	1.3	0.1%
Total Kcal	1664.9			1899.4			1883.93	

Considering each food type the linear mixed model below was used to estimate the effect of seasons on kilocalorie amounts by food type:

Log daily kilocalorie intake (specific food item/category) = season + height + (1|id) [l]

The model estimates for each model are reported in Table 19, and Table 20 summarizes the results of the model.

Table 19. Linear mixed model results for selected energy rich foods in adolescent's dietary recalls.

Fixed Effects Model	**Rainy Season**	**Dry Season**		**Transition Season**	
		Estimate	%Δ	*Estimate*	%Δ
Farinha	Ref.	-0.16 (-0.8)	-15.4	-0.13 (-0.63)	-12.7
Other group 3 foods	Ref.	-0.8 (-1.71)	-55.1	-0.34 (-0.71)	-28.8
Fried bananas	Ref.	2.75 (4.95)**	**1472.4**	2.63 (4.38)**	**1282.7**
Fish	Ref.	-0.74 (-3.38)**	**-52.2**	-0.67 (-2.75)**	**-48.6**
Fruit	Ref.	0.01 (0.03)	1.1	1 (2.29)*	**173**
Crackers	Ref.	-0.34 (-0.98)	-29	-0.31 (-0.88)	-27
Other group 0 foods	Ref.	0.34 (0.36)	40	-0.26 (-0.27)	-22.7
Oil added to dishes	Ref.	0.76 (3.13)**	**114.6**	0.81 (2.58)*	**124.8**
Sugar	Ref.	-0.19 (-0.85)	-17.2	-0.28 (-1.21)	-24.7
Other group 1 foods	Ref.	0.52 (096)	68.52	1.20 (2.06) .	**233.9**
Other group 2 foods	Ref.	-0.15 (-0.21)	-14.2	-0.44 (-0.57)	-35.7
Rice	Ref.	0.47 (1.98) .	**60**	0.37 (1.53)	44.77
Pasta	Ref.	0.36 (0.83)	43.3	0.60 (1.35)	82.21

t statistics of each model in parenthesis, N=48, 10 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

[l] (1|id) assumes random effects by participant, meaning that the model adopts different intercepts for each participant, accounting for repeated recalls with the same participants.

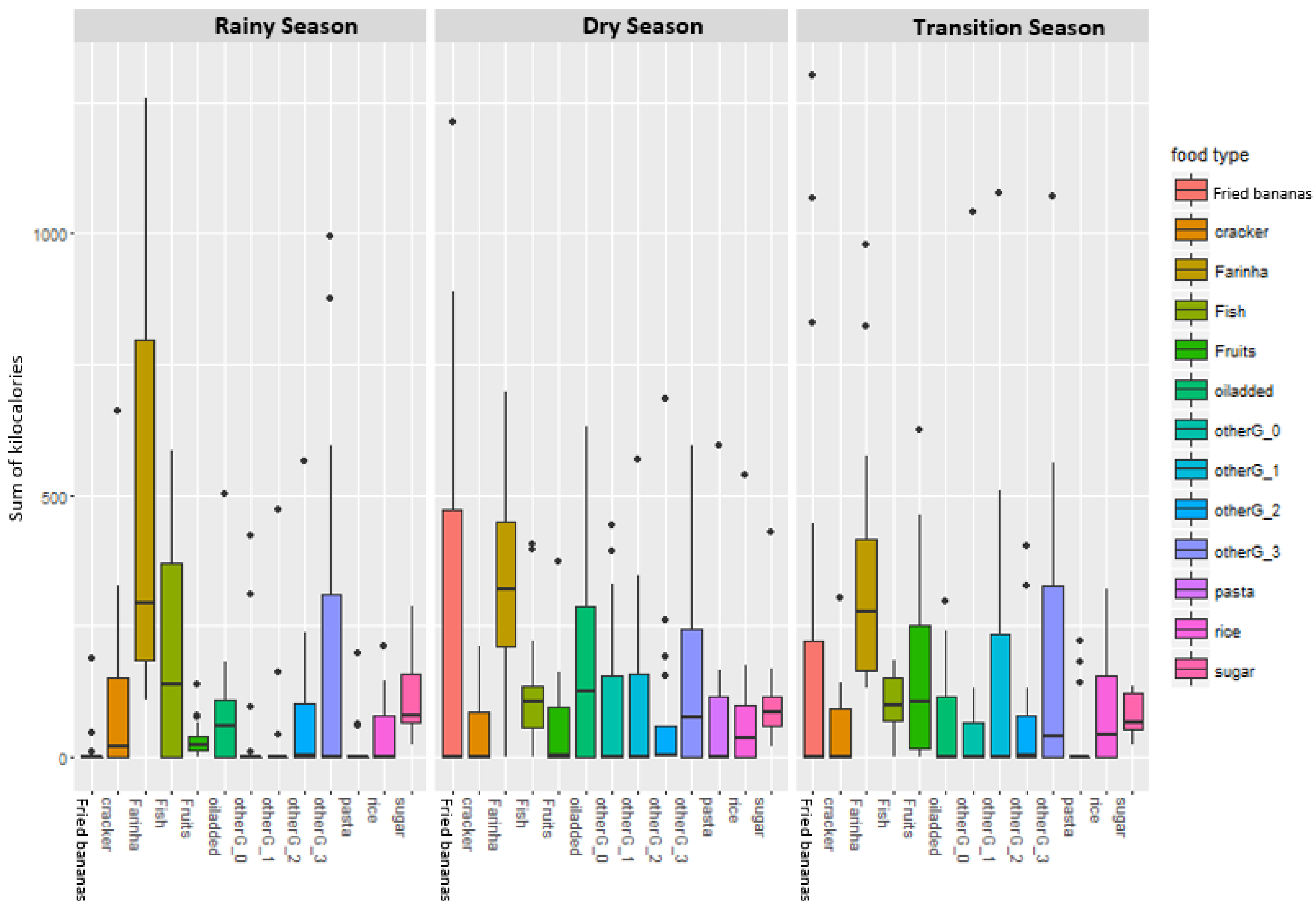
Results show no significant difference in daily caloric intake across seasons for female adolescents (*Table 17*). However, when investigating food types and categories separately, there are changes in consumption across seasons (Table 19). There is a higher consumption of fried bananas, vegetable oil added to dishes and rice in the dry season, compared to the rainy season. Also, on average, adolescent females are consuming 52% less calories from prepared fish in the dry season compared to the rainy season. In contrast, they are consuming on average almost 15 times more calories from fried bananas, more than double the calories from vegetable oil added to dishes, and 60% more rice in the dry season compared to the rainy season (Table 19). In the transition season, there was also a lower contribution of calories in daily intake from prepared fish, compared to the rainy season (49% less), and a higher caloric contribution or fried bananas (1283%) and vegetable oil added to dishes (125%).

Table 20. Summary of differences in daily kcal contribution of foods across seasons for adolescent females

Average daily Kcal intake	**Compared to dry season***
Higher in rainy season	Prepared fish (52%)
Lower in rainy season	Fried bananas (1472%), vegetable oil added to dishes (115%), and rice (60%)
No difference from rainy season	Farinha, other group 3 foods, fruit, crackers, other group 0 foods, sugar, other group 1 goods, other group 2 foods, and pasta
Excluded from model: low kilocalorie content foods, low serving size or low sample size	Beans, beef, chicken, dairy powder, eggs, game, and seasonings

Using a descriptive analysis, the median kilocalorie intake and values between the 25^{th} and 75^{th} percentiles (boxes) for food categories appear lower in the rainy season, compared to most median values in other seasons. This pattern suggests a higher and more consistent contribution to kilocalorie intake from different foods in the dry season, or a more diversified diet, compared to the sources of kilocalories in the rainy season.

Figure 34. Sum of energy contribution (Kcal) from selected kilocalorie rich food types across seasons for adolescent females.



Food sources of protein in adolescent female's diets

For adolescent females, fish is the most significant protein rich food in diets, compared to all other sources and independent of the season (Figure 35). Fish contributes with more than 30% of the daily protein intake across seasons, but other food categories together seem to be accounting for a significant percentage as well, including highly industrialized foods (group 3), chicken, beans and game, depending on the season (Table 21). Seasonings appeared as important, possibly given their frequency in diets. However, seasoning amounts might have been exacerbated during data collection, as, proportions of these items in recipes were extrapolated from one cook to all other hou seholds. Other items accounted for less than 7% of the protein intake individually across seasons (Table 21)

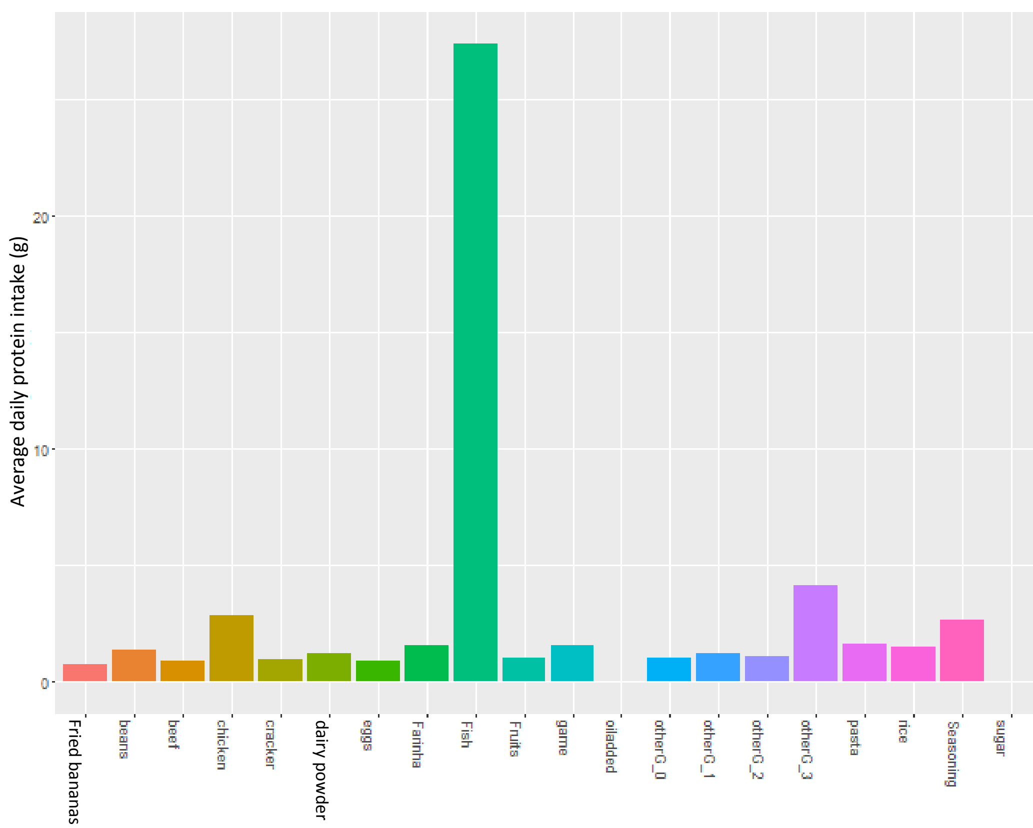
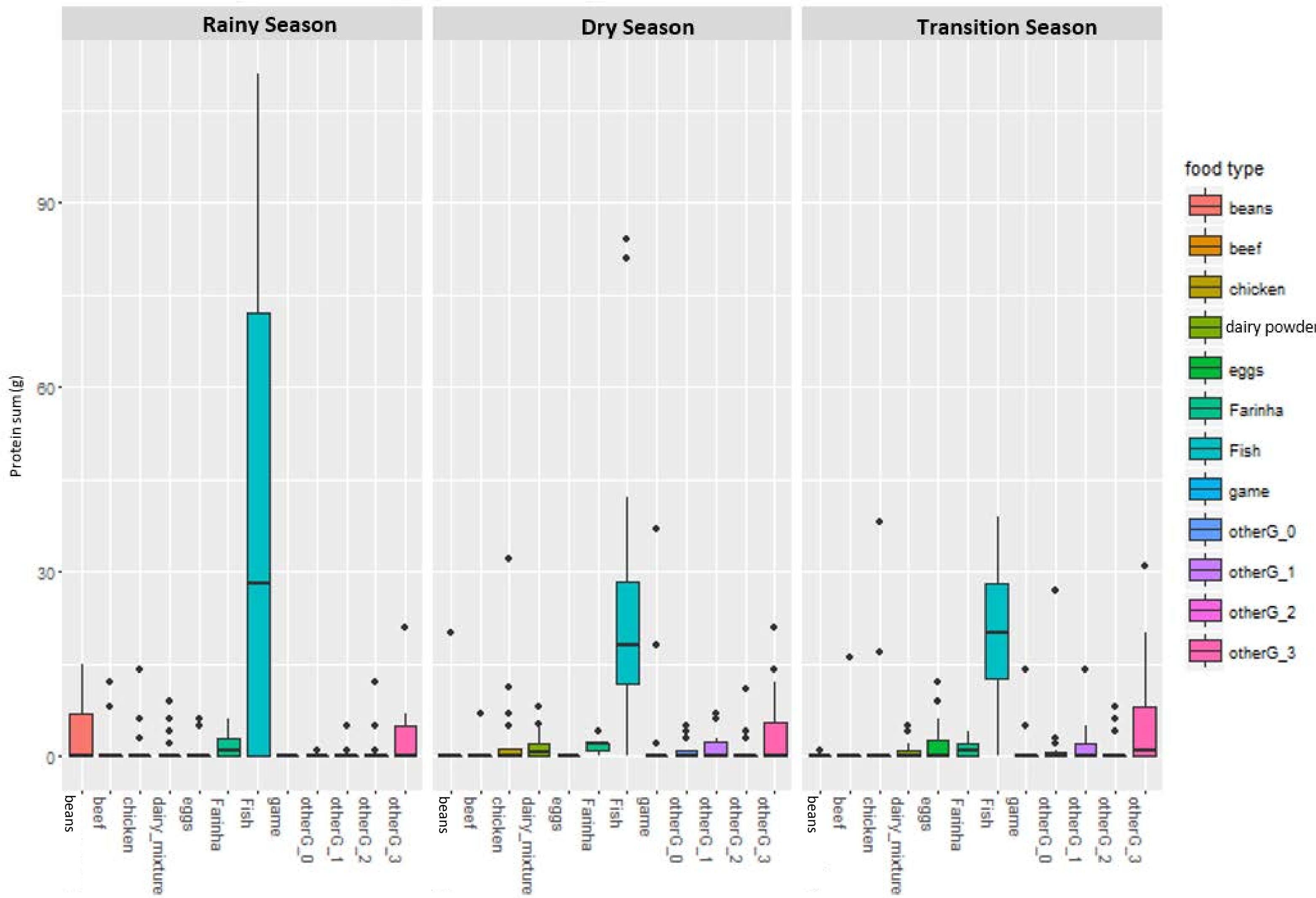


Figure 35. Average daily protein intake (g) by food type/category for adolescent females.

Table 21. Food item average by recall, and percentage of total protein intake.

Rainy Season (N= 17 recalls)			Dry Season (N= 16 recalls)			Transition Season (N= 15 recalls)		
Food items (g)	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*
Fish	36	66.1%	Fish	26	46.7%	Fish	19	37.5%
Other group 3 foods	2.8	5.1%	Other group 3 foods	4.0	7.2%	Other group 3 foods	5.9	11.6%
Beans	2.7	5 %	Game	3.6	6.4%	Chicken	3.7	7.2%
Farinha	1.9	3.5%	Chicken	3.4	6.2%	Seasonings	2.9	5.7%
Crackers	1.5	2.8%	Seasoning	3.1	5.7%	Fruit	2.3	4.6%
Chicken	1.5	2.8%	Pasta	2.9	5.3%	Other group 0 foods	2.2	4.3%
Seasoning	1.4	2.7%	Rice	1.8	3.1%	Eggs	2.1	4.2%
Dairy powder	1.2	2.3%	Dairy powder	1.6	2.9%	Other group 1 foods	1.9	3.7%
Beef	1.2	2.2%	Farinha	1.5	2.7%	Rice	1.8	3.6%
Other group 2 foods	1	1.9%	Other group 1 foods	1.4	2.6%	Farinha	1.3	2.6%
Rice	1	1.8%	Beans	1.2	2.2%	Pasta	1.3	2.6%
Pasta	0.6	1.2%	Fried bananas	1.1	2%	Game	1.3	2.5%
Eggs	0.6	1.2%	Other group 2 foods	1.1	2%	Other group 2 foods	1.2	2.4%
All others	0.8	1.5%	All others	2.7	5%	All others	3.7	7.4%
Total Kcal	54.5			55.6			50.6	

Figure 36. Daily protein intake (g) per selected food types across seasons for adolescent females.



Considering daily protein intake from each food type the linear mixed model below was used to estimate the effect of seasons by food type:

Log daily protein intake = season + height + (1|id) [m]

The model estimates for fish and other foods of group 3 are reported in Table 22, and Table 23 summarizes the results of the model. There was a significant difference in daily protein intake from fish and other foods of group 3 between seasons. On average, adolescent females are consuming 51.6% less protein from fish in the dry season, and 49.3 % less in the transition season, compared to the rainy season ($p<0.1$, Table 22).

Table 22. LMM for selected protein rich foods in female adolescent dietary recalls.

Fixed Effects Model	**Rainy Season**	**Dry Season**		**Transition Season**	
		Estimate	%Δ	*Estimate*	%Δ
Fish	Ref.	-0.72 (-3.31)**	**-51.5**	-0.67 (-2.78)**	**-49**
Other group 3 foods	Ref.	0.16 (0.29)	17.77	0.56 (0.99)	74.6

Interaction t statistics in parenthesis, N=48, 10 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Table 23. Summary of differences in daily caloric contribution of foods across seasons.

Average daily protein intake	**Compared to dry season**
Higher in rainy season	Fish (51.5%)
No difference between season	Highly industrialized foods (group 3)
Excluded from model: no protein or very low protein content foods (or low serving size)	Sugar, vegetable oil, fruits, other group 2 foods, other group 0 foods, farinha, crackers, fried bananas, pasta, rice, seasonings, other group 1 foods, and dairy powder
Excluded from model: protein rich foods with sample size lower than 4 per season	Chicken, eggs, game, beans, and beef

In sum, again, results show the importance of fish as a protein source in female adolescent diets across seasons. However, the contribution of protein from fish was higher in

[m] (1|id) assumes random effects by participant, meaning that the model adopts different intercepts for each participant, accounting for repeated recalls with the same participants.

the rainy season compared to the other seasons, a difference which was not present for adult women. A combination of food items/categories seem to be responsible for protein intake in the dry and transition season, including industrialized foods of group 3, game, chicken, dairy powder, and eggs (Figure 36).

Food sources of fat in adolescent female's diets

In terms of daily fat intake, the main food sources overall for adolescent females were vegetable oil added to dishes, followed by fried bananas and other foods of group 3 (Figure 37). When looking at differences across seasons, the main foods responsible for fat intake varied from vegetable oil added to dishes and fried bananas, while other foods of group 3, and other foods of group 1 were also among the most important in terms of providing higher quantities of fat in people's diets (Table 24).

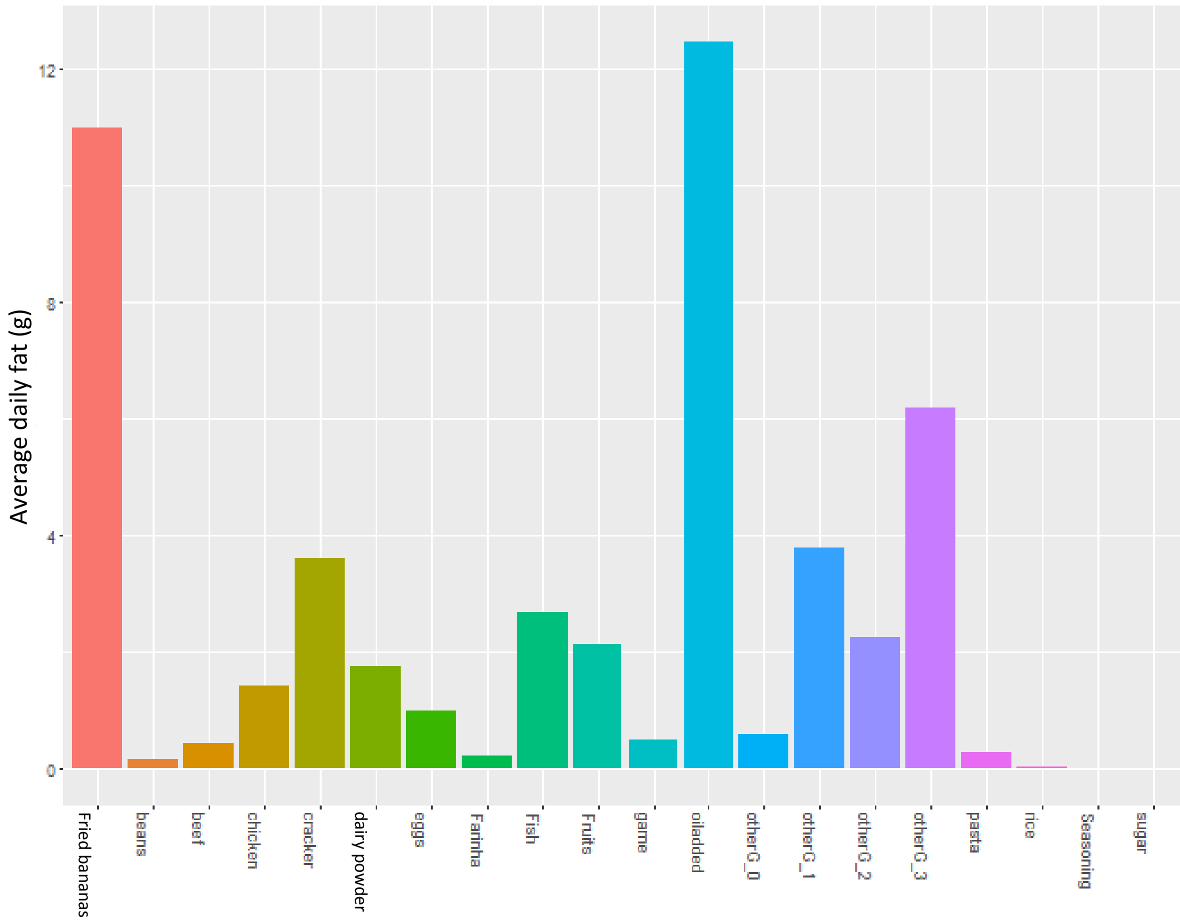
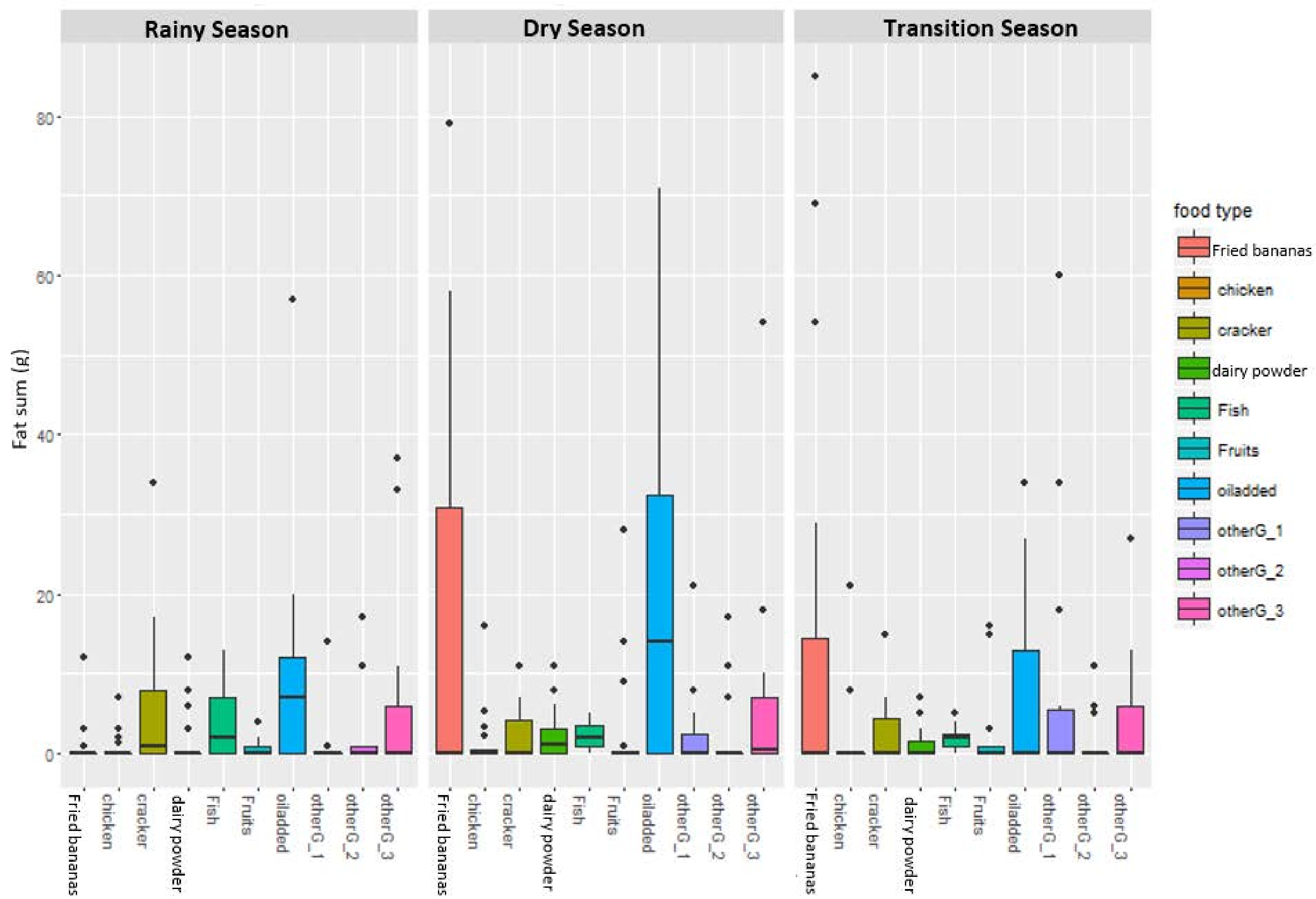


Figure 37. Average daily fat intake (g) by food type for female adolescents.

Table 24. Food item average contributions and average percentage of total fat intake.

Rainy Season (N= 17 recalls)			**Dry Season (N= 16 recalls)**			**Transition Season (N= 15 recalls)**		
Food items (g)	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*
Oil added	9.7	25.7%	Oil added	20.1	32.6%	Fried bananas	15.8	30.1%
Other group 3 foods	7.7	20.4%	Fried bananas	16.5	26.7%	Other group 1 foods	8.2	15.6%
Crackers	5.9	15.7%	Other group 3 foods	6.4	10.4%	Oil added	7.5	14.2%
Fish	3.6	9.7%	Fruits	3.2	5.3%	Other group 3 foods	4.2	8.1%
Other group 2 foods	3	7.9%	Other group 1 foods	2.7	4.3%	Fruits	2.5	4.8%
Dairy powder	1.7	4.5%	Fish	2.4	3.9%	Crackers	2.4	4.6%
Fried bananas	0.9	2.5%	Dairy powder	2.3	3.8%	Eggs	2.4	4.6%
Other group 1 foods	0.9	2.5%	Crackers	2.2	3.6%	Chicken	1.9	3.7%
Chicken	0.8	2.1%	Other group 2 foods	2.2	3.5%	Fish	1.9	3.6%
Eggs	0.7	1.9%	Chicken	1.7	2.7%	Other group 2 foods	1.5	2.8%
Fruits	0.7	1.9%	Game	1	1.6%	Other group 0 foods	1.3	2.4%
Other group 0 foods	0.6	1.6%	Pasta	0.5	0.8%	Dairy powder	1.2	2.3%
All others	1.3	3.6%	All others	0.4	0.7%	All others	1.7	3.2%
Total Kcal	37.7			61.8			52.43	

Figure 38. Daily fat intake (g) per selected food types across seasons for adolescent females.



From a descriptive analysis, fish seems to be contributing more fat in the rainy season compared to the dry and transition seasons, which is not surprising, mimicking caloric and protein differences. Of the 39 recalls in which fish was present, more than half fat daily intakes were of 1 or2 grams (Figure 39).

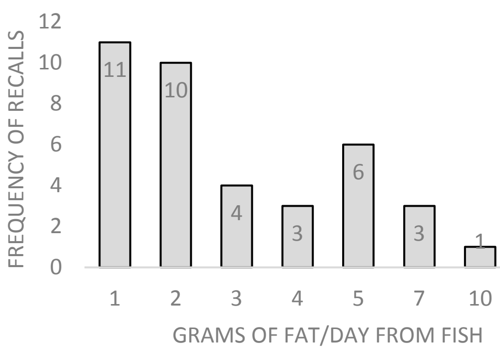


Figure 39. Fat intake from fish for adolescent females.

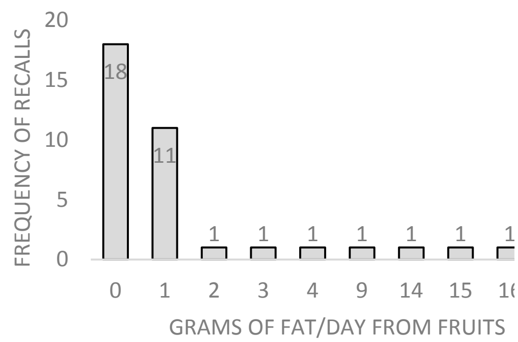


Figure 40. Fat intake from fruits for adolescent females.

In terms of fruits, a descriptive analysis shows that fruits consumed in the dry and transition season probably have higher fat content, even though consumption of fatty fruits might not be that frequent, with lots of outliers (Figure 39). Also, of the 37 recalls in which fruit was present, 29 were equal to 0 or 1 g of fat per day (Figure 40).

Considering each food type, as outlined in the analysis section, the linear mixed model below was used to estimate the effect of seasons on fat intake by food type:

Log daily fat intake (specific food item/category) = season + height + (1|id) [n]

The estimates for each model are reported in Table 25, and Table 26 summarizes the results of the model.

[n] (1|id) assumes random effects by participant, meaning that the model adopts different intercepts for each participant, accounting for repeated recalls with the same participants.

Table 25. Linear mixed model results for selected fat rich foods in adolescent females' dietary recalls.

Fixed Effects Model	Rainy Season	Dry Season		Transition Season	
		Estimate	%Δ	Estimate	%Δ
Oil added to dishes	Ref.	0.72 (3.09)**	**105.44**	0.71 (2.53)*	**113**
Fried bananas	Ref.	2.32 (5.69)**	**904.83**	2.14 (4.83)**	**773.9**
Other group 3 foods	Ref.	-0.43 (-0.68)	-34.95	-0.59 (-0.92)	-41.73
Crackers	Ref.	-0.31 (-1.07)	-26.71	-0.32 (-1.07)	-27.30
Other group 1 foods	Ref.	0.59 (1.3)	80.58	1.76 (3)*	**480.14**

t statistics of each model in parenthesis, N=48, 10 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

There was a significantly higher daily fat intake from vegetable oil added to dishes, and fried bananas in the dry season compared to the rainy season, reflecting a higher daily intake of fats in the dry season, as shown on Table 25. Also, in the transition season, there was a higher intake of fat from both vegetable oil added to dishes, fried bananas, and other group 1 foods, compared to the rainy season. Table 26 summarizes the results.

Table 26. Summary of differences in daily fat contribution of foods across seasons for adolescent females.

Average daily fat intake	Compared to dry season*
Lower in rainy season	Oil added to dishes (105.4%), Fried bananas (914.8%)
No difference from rainy season	Other group 3 foods, crackers, and other group 1 foods
Excluded from model: no fat, very low fat content foods, or low serving size	Sugar, seasonings, rice, other group 2 foods, other group 0 foods, farinha, pasta, rice, dairy powder, fruits, and fish
Excluded from model: sample size lower than 4 recalls in each season	Chicken, eggs, game, beans, and beef

In sum, for adolescent females, the higher daily fat intake observed in the dry season is mainly accounted for by the higher consumption of vegetable oil added to dishes and fried bananas. To a smaller extent mixed recipes such as starchy snacks (other group 1) and fruits seem to also be contributing with higher amounts of fat, even though consumption of fatty fruits such as açaí and buriti are seasonal, and not very frequent.

MALE ADOLESCENTS INTAKE

The 24-hour recalls taken with adolescent males showed an average energy intake of 2116 Kcal with considerable variations between recalls, given that the standard deviation represents 43% of the average value (Table 27). The average protein consumption was 64.6 g, and the variation among individual recalls for protein was also high, 54%, of the average calculated intake value.

Table 27. Adolescent male dietary intake for all seasons.

	Max.	***Min***	***Mean ± SD***	***% of total Kcal Intake (Atwater)***
Total (Kcal)	5092	654	2116 ± 908.7	66.1
Carbohydrate (g)	890	118	358.6 ± 159.3	12
Protein (g)	203	18	64.6 ± 35.2	22
Fat (g)	141	4	52.8 ± 33	

The average kilocalorie intake for male adolescents was also under the recommended levels, values were 93.6%, 93% and 78.8% for the rainy, dry, and transition season respectively. Again, as the results for mothers and adolescent females, the average protein intake was higher than recommended levels, 144.2%, 163.9%, and 139.5% respectively for the rainy, dry and transition seasons (Table 28).

Table 28. Adolescent male dietary intake by season.

	Rainy season (May 2014)		**Dry season (September 2014)**		**Transition season (January 2015)**	
	Mean ± SD	*% (Kcal Intake)*	*Mean ± SD*	*% (Kcal Intake)*	*Mean ± SD*	*% (Kcal Intake)*
Total (Kcal)	2247 ± 1101.5		2232 ± 765.2		1891 ± 685.1	
Carbs (g)	390.3 ± 196.9	69.4	357.1 ± 126.7	64	298 ± 109.2	62.7
Protein (g)	62 ± 41	11	70.5 ± 32.8	12.6	60 ± 26.1	12.6
Fat (g)	48.8 ± 35.3	19.5	57.9 ± 32.4	23.4	52.2 ± 30.1	24.7

The results of the linear mixed models for adolescent males, used to test the effect of seasonality on dietary intake, are presented below. Results show that no statistical difference was observed for macronutrient intake between seasons (Table 29).

Results from the linear mixed models with adolescent males are listed below:

- There was no significant difference in daily kilocalorie intake between dry and rainy seasons, β= -2238.17, t(196.64) = 1.61, p=0.99;
- There was no significant difference in daily carbohydrate intake between dry and rainy seasons, β= -32.5 t(51.34)= -0.98, p=0.33;
- There was no significant difference in daily protein intake between dry and rainy seasons, β= 8.51, t(9.85)= 0.86, p=0.39;
- There was no significant difference in daily fat intake between dry and rainy seasons, β= 9.93, t(8.73)= 1.14, p=0.26;

Table 29. Linear mixed model results for adolescent males.

Fixed Effects	**Kilocalories Model**	**Carbohydrates Model**	**Protein Model**	**Fat Model**
Reference group: rainy season				
Constant	2238.17	388.81	61.96***	48.67***
	(11.38)	(10.96)	(9.26)	(7.32)
Dry season	2.99	-32.5	8.51	9.93
	(0.01)	(-0.98)	(0.86)	(1.14)
Transition season	-353.25	-85.64	-1.92	1.49
	(-1.4)	(-2.16)	(-0.16)	(0.14)

t statistics in parenthesis, N=66, 15 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

SOURCES OF FOOD FOR ADOLESCENT MALES

The results above show no difference in macronutrient dietary intake across seasons. The analysis below addresses the consumption of specific foods across seasons, and was conducted along the same lines as previously done for mothers' and adolescent females' dietary recall data.

Food sources of kilocalories in adolescent male's diets

Just as observed for mothers and female adolescents, the main sources of kilocalorie intake across seasons is farinha. Analogous to adolescent girls, highly industrialized foods (group 3) were the second highest food/category kilocalorie contributor in adolescent male's diets, after farinha, followed by prepared fish and banana chips (Figure 41).

The main kilocalorie contributors for daily intake of male adolescents varied across seasons, including highly industrialized foods (group), fried bananas, prepared fish and vegetable oil (Table 30). Farinha contributed with more than 22% of the daily calories on average across all seasons, similar to the proportions observed for women. The kilocalorie contribution of each categorized food item was calculated based on the percentage of contribution in each food recall per season (Table 30, Figure 41). This ranking of importance informed the analysis of the effects of season on the consumption of specific food items.

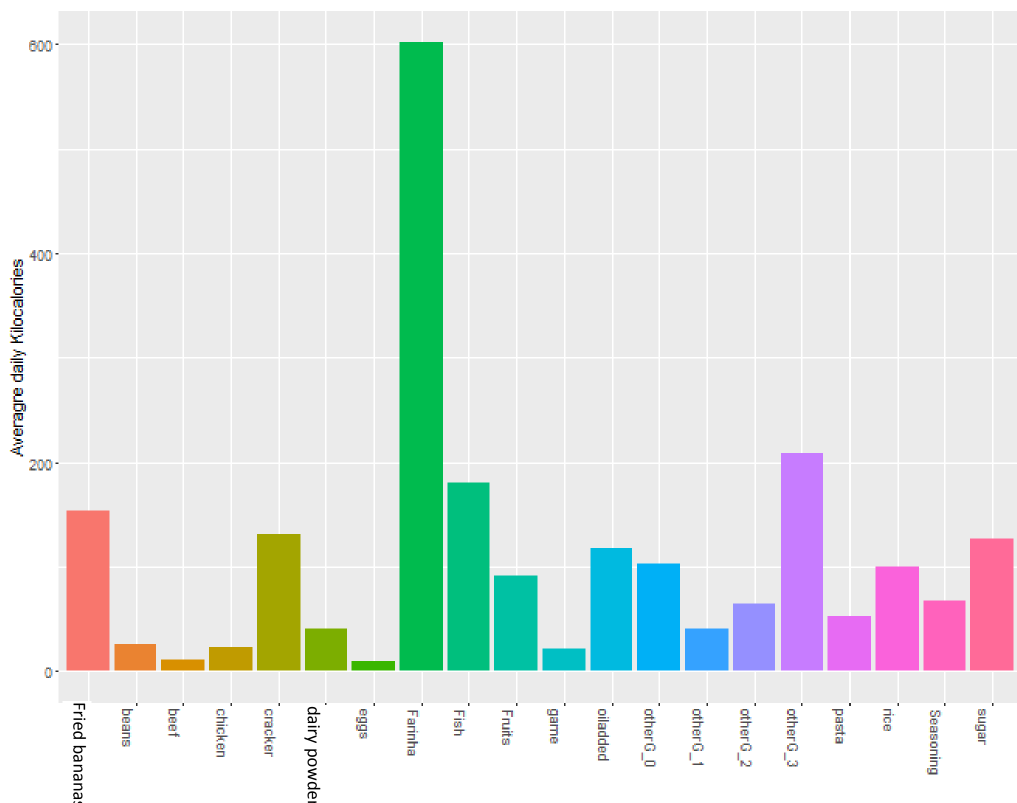


Figure 41. Average daily kilocalorie intake by food type for adolescent males.

Table 30. Food item average contributions and average percentage of total intake (male adolescent recalls).

Rainy Season (N= 28 recalls)			Dry Season (N= 24 recalls)			Transition Season (N= 14 recalls)		
Food items (Kcal)	*Mean*	*% intake*	*Food item (Kcal)*	*Mean*	*% intake*	*Food item (Kcal)*	*Mean*	*% intake*
Farinha	710.3	31.6%	Farinha	582.3	26.1%	Farinha	419.4	22.2%
Other group 3 foods	238.9	10.6%	Other group 3 foods	199.5	8.9%	Oil added	169.5	9.0%
Fried bananas	220.3	9.8%	Fish	187.8	8.4%	Other group 3 foods	164.3	8.7%
Fish	189.3	8.4%	Oil added	175.8	7.9%	Fish	151.0	8.0%
Sugar	156.6	7.0%	Other group 1 foods	138	6.2%	Fruits	144.7	7.7%
Cracker	145.9	6.5%	Cracker	121.3	5.4%	Fried bananas	115.9	6.1%
Fruits	93.5	4.2%	Sugar	116.6	5.2%	Cracker	114.6	6.1%
Rice	83.6	3.7%	Rice	111.3	5.0%	Rice	112.6	6.0%
Other group 1 foods	71.25	3.2%	Fried bananas	98.5	4.4%	Seasoning	94.1	5.0%
Pasta	47.4	2.1%	Seasoning	93.7	4.2%	Sugar	84.2	4.5%
Other group 2 foods	46.5	2.1%	Pasta	78.6	3.5%	Other group 2 foods	79.5	4.2%
Other group 0 foods	46.5	2.1%	Other group 2 foods	75.6	3.4%	Other group 0 foods	53.1	2.8%
Oil added	43.0	1.9%	Other group 0 foods	63.6	2.9%	Dairy Powder	44.8	2.4%
Beans	38.0	1.7%	Fruits	55.5	2.5%	Other group 1 foods	40.9	2.2%
Dairy Powder	33.1	1.5%	Dairy Powder	45.4	2.0%	Chicken	28.4	1.5%
Seasoning	30.8	1.4%	Game	29.8	1.3%	Beans	22.3	1.2%
Chicken	21.6	1.0%	Eggs	22.0	1.0%	Game	22.0	1.2%
Beef	14.0	0.6%	Chicken	19.3	0.9%	Pasta	20.6	1.1%
Game	13.9	0.6%	Beans	11.1	0.5%	Beef	9.5	0.5%
Eggs	2.4	0.1%	Beef	6.3	0.3%	Eggs	0	0%
Total Kcal	2246.6			2232.1			1891.5	

Considering each food type the linear mixed model below was used to estimate the effect of seasons on kilocalorie amounts by food type:

Log daily kilocalorie intake (specific food item/category) = season + height + (1|id) [o]

The model estimates for each model are reported in Table 31, and Table 32 summarizes the results of the models.

Table 31. Linear mixed model results for selected energy rich foods in adolescent male's dietary recalls.

Fixed Effects Model	**Rainy Season**	**Dry Season**		**Transition Season**	
		Estimate	%Δ	*Estimate*	%Δ
Farinha	Ref.	-0.09 (-0.65)	-8.24	-0.71 (-3.82)***	**-51.09**
Other group 3 foods	Ref.	0.33 (0.98)	39.64	0.27 (0.64)	30.98
Fried bananas	Ref.	0.28 (0.55)	31.85	-1.04 (-1.64)	-64.65
Fish	Ref.	0.04 (0.14)	3.76	-0.51 (-1.46)	-40.18
Fruit	Ref.	0.21 (0.48)	23.73	0.19 (0.37)	21.11
Crackers	Ref.	-0.32 (-2.6)*	**-44.9**	-0.34 (-1.72) .	**-37.8**
Other group 0 foods	Ref.	0.99 (0.93)	170.39	-0.33 (-0.28)	-28.52
Oil added to dishes	Ref.	0.98 (2.45)*	**167.49**	0.38 (0.82)	46.83
Sugar	Ref.	-0.31 (-1.86) .	**-26.38**	-0.63 (-2.57)*	**-46.59**
Other group 2 foods	Ref.	0.52 (0.92)	68.76	1 (1.38)	186.28
Rice	Ref.	0.45 (1.85) .	**56.75**	0.24 (0.88)	26.73
Pasta	Ref.	0 (0.01)	0.49	-0.9 (-1.98) .	**-60.5**
Other group 1 foods	Ref.	0.25 (0.64)	28.62	-1.1 (-1.86) .	**-65.6**

t statistics of each model in parenthesis, N=66, 15 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

[o] (1|id) assumes random effects by participant, meaning that the model adopts different intercepts for each participant, accounting for repeated recalls with the same participants.

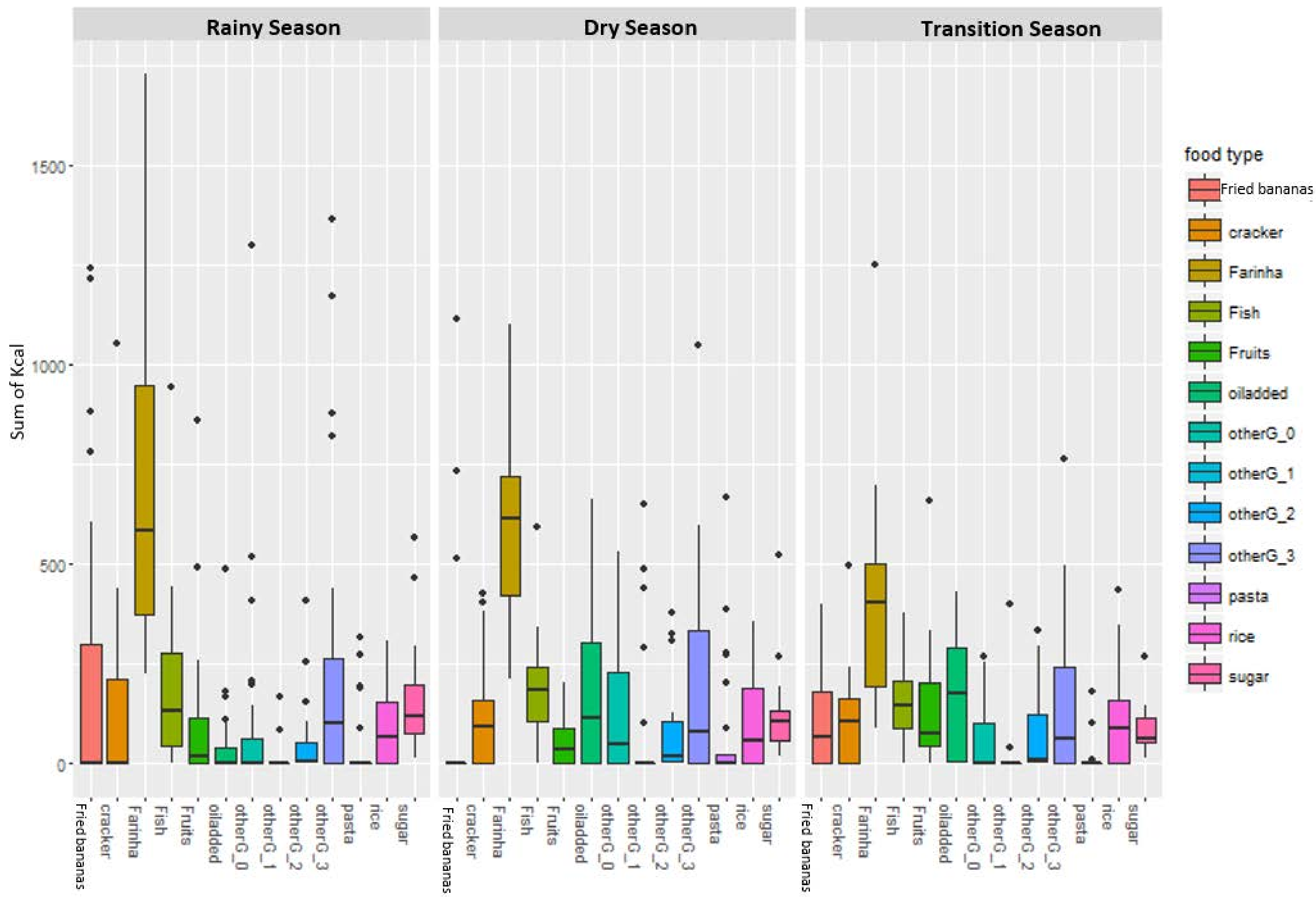
Results showed no significant difference in daily kilocalorie intake across seasons for male adolescents (Table 29). However, when investigating food types and categories separately, we observe changes in consumption following the different seasons (Table 31). There is a higher consumption of vegetable oil added to dishes and rice in the dry season, compared to the rainy season. Respectively, on average, adolescent males are consuming 45% and 26% less calories from crackers and sugars in the dry season compared to the rainy season. In contrast, they are consuming on average more than double kilocalories from vegetable oil added to dishes, and 55.6% more rice in the dry season compared to the rainy season (Table 31). In the transition season, there was a lower contribution of calories in daily intake from farinha (42% less), crackers (38% less), sugar (46% less), and pasta (80% less) compared to the rainy season (Table 31).

Table 32. Summary of differences in daily kcal contribution of foods across seasons for adolescent females.

Average daily Kcal intake	**Compared to dry season***
Higher in rainy season	Crackers (45%) and sugar (26%)
Lower in rainy season	Vegetable oil added to dishes (167%) and rice (57%)
No difference from rainy season	Farinha, other group 3 foods, fried bananas, fish, fruit, other group 0 foods, sugar, other group 2 foods, and pasta
Excluded from model: low kilocalorie content foods, low serving size or low sample size	Beans, beef, chicken, dairy powder, eggs, game, seasonings, and other group 1 foods.

Using a descriptive analysis, the 25th and 75th percentiles (boxes) for food categories appear quite similar across seasons (Figure 42). In general, this pattern suggests a more consistent contribution to kilocalorie intake from different foods across seasons, and possibly not as much variation as noted in mothers and female adolescents' sources of kilocalories in diets.

Figure 42. Daily kilocalorie intake per selected food types across seasons for adolescent males.



Food sources of protein in adolescent male’s diets

Just as for mothers and adolescent females, in terms of protein intake, fish is the most significant protein rich food in adolescent male’s diets compared to all other sources, independent of the season (Figure 43).

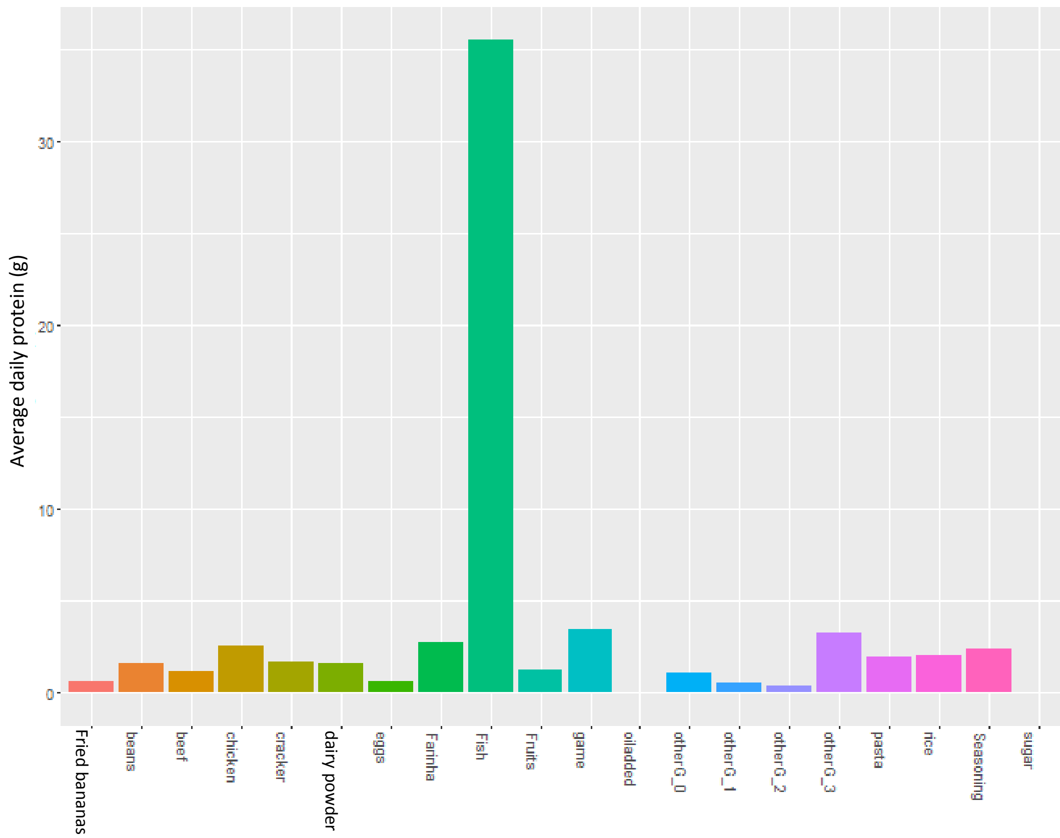


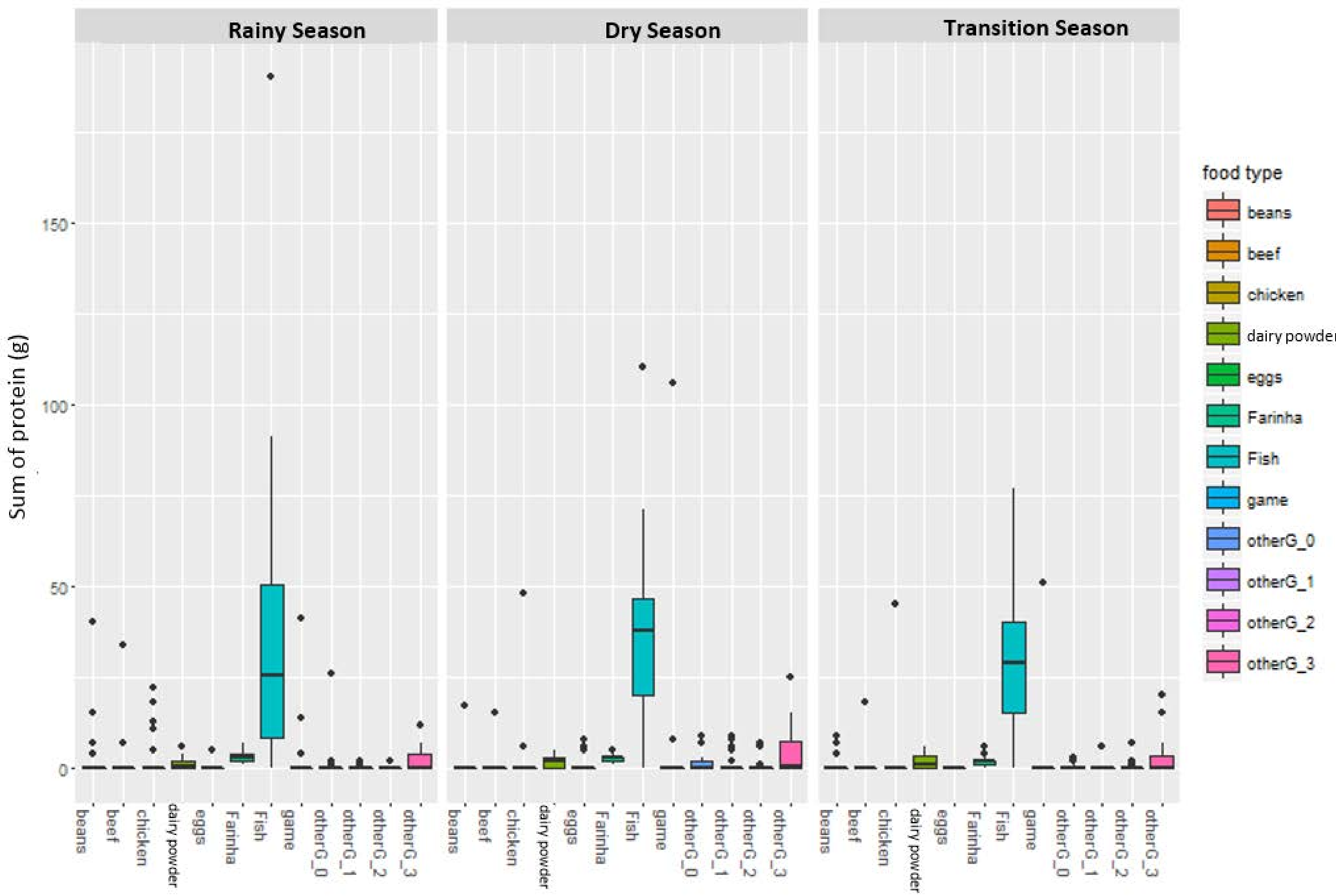
Figure 43. Average daily protein intake (g) by food type/category for adolescent males.

Fish contributes with more than 50% of the daily protein intake across seasons. These results show the importance of fish for protein intake in male adolescent’s diets. Interestingly, male adolescent and mother’s sources of protein intake seem to be similar and more based in fish consumption across seasons, whereas female adolescents’ results for fish consumption were more varied across seasons. In the case of male adolescents, the food items or categories accounting for other minor parcels of protein intake are game, other highly industrialized foods (group 3), chicken, farinha, and seasonings, the latter 2 items consumed in large amounts, and all five individually accounting for less than 7% of the total protein intake per season (Table 33).

Table 33. Food item average contributions and average percentage of total protein intake.

Rainy Season (N= 28 recalls)			**Dry Season (N= 24 recalls)**			**Transition Season (N= 14 recalls)**		
Food items (g)	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*
Fish	37.3	60.2%	Fish	36.6	51.9%	Fish	30.2	50.3%
Farinha	3.1	5%	Other group 3 foods	4.8	6.8%	Seasoning	3.8	6.3%
Chicken	2.5	4%	Game	4.7	6.7%	Game	3.6	6.1%
Beans	2.3	3.8%	Seasoning	3.3	4.7%	Other group 3 foods	3.4	5.7%
Game	2.2	3.6%	Pasta	2.9	4.1%	Chicken	3.2	5.4%
Other group 3 foods	1.9	3.1%	Farinha	2.7	3.9%	Rice	2.5	4.2%
Crackers	1.9	3%	Rice	2.3	3.3%	Fruits	2.1	3.6%
Pasta	1.8	2.9%	Chicken	2.2	3.2%	Farinha	2	3.3%
Rice	1.6	2.6%	Dairy powder	1.9	2.7%	Dairy powder	1.8	3.1%
Beef	1.5	2.4%	Crackers	1.7	2.4%	Crackers	1.6	2.6%
Dairy Powder	1.3	2.1%	Eggs	1.5	2.2%	Beans	1.4	2.4%
Fruits	1.2	2%	Other group 0 foods	1.3	1.9%	Beef	1.3	2.1%
Other group 0 foods	1.1	1.8%	Other group 1 foods	1.2	1.8%	Pasta	0.8	1.3%
Seasonings	1	1.6%	Fruits	0.8	1.2%	Other group 2 foods	0.7	1.2%
Fried bananas	0.9	1.4%	Beans	0.7	1%	Other group 0 foods	0.6	1%
Eggs	0.2	0.3%	Beef	0.6	0.9%	Fried bananas	0.5	0.8%
All others	0.18	0.3%	All others	1	1.4%	All others	0.4	0.7%
Total Kcal	62			70.5			60	

Figure 44. Daily protein intake (g) per selected food types across seasons for adolescent males.



Given the limitations outlined above, the linear mixed model included daily protein intake as the dependent variable only for two food types/categories, prepared fish and other highly industrialized foods (group 3).

Considering protein daily intake from each food type the linear mixed model below was used to estimate the effect of seasons by food type:

Log daily protein intake = season + height + (1|id) [p]

Table 34. LMM for selected protein rich foods in female adolescent dietary recalls.

Fixed Effects Model	Rainy Season	Dry Season		Transition Season	
		Estimate	%Δ	*Estimate*	%Δ
Fish	Ref.	0.02 (0.09)	2.5	-0.47 (-1.4)	-37.5
Other group 3 foods	Ref.	1 (4.11)***	**177.3**	0.3 (0.96)	35.5

Interaction t statistics in parenthesis, N=48, 10 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Table 35. Summary of differences in daily caloric contribution of foods across seasons.

Average daily protein intake	Compared to dry season
Lower in rainy season	Other group 3 foods (177.3%)
No difference from rainy season	Fish
Excluded from model: no protein or very low protein content foods (or low serving size)	Sugar, vegetable oil, fruits, other group 2 foods, other group 0 foods, farinha, crackers, fried bananas, pasta, rice, seasonings, other group 1 foods, and dairy powder
Excluded from model: protein rich foods with sample size lower than 4 per season	Chicken, eggs, game, beans, and beef

There was no significant difference in protein intake from prepared fish in adolescent male's intake across seasons. Conversely, there was a significant difference in daily protein intake from other highly industrialized foods (group 3) between seasons. On average,

[p] (1|id) assumes random effects by participant, meaning that the model adopts different intercepts for each participant, accounting for repeated recalls with the same participants.

adolescent males are consuming 166% more protein from other highly industrialized foods in the dry season compared to the rainy season ($p<0.001$, Table 34).

Again, results show the importance of fish as a protein source in male adolescent diets across seasons. Other highly industrialized foods (group 3) are contributing with a higher intake of protein in the dry season compared to the rainy season, for adolescent males.

Food sources of fat in adolescent male’s diets

In terms of daily fat intake, the main food sources overall for adolescent males were vegetable oil added to dishes, followed by fried bananas and crackers (Figure 45).

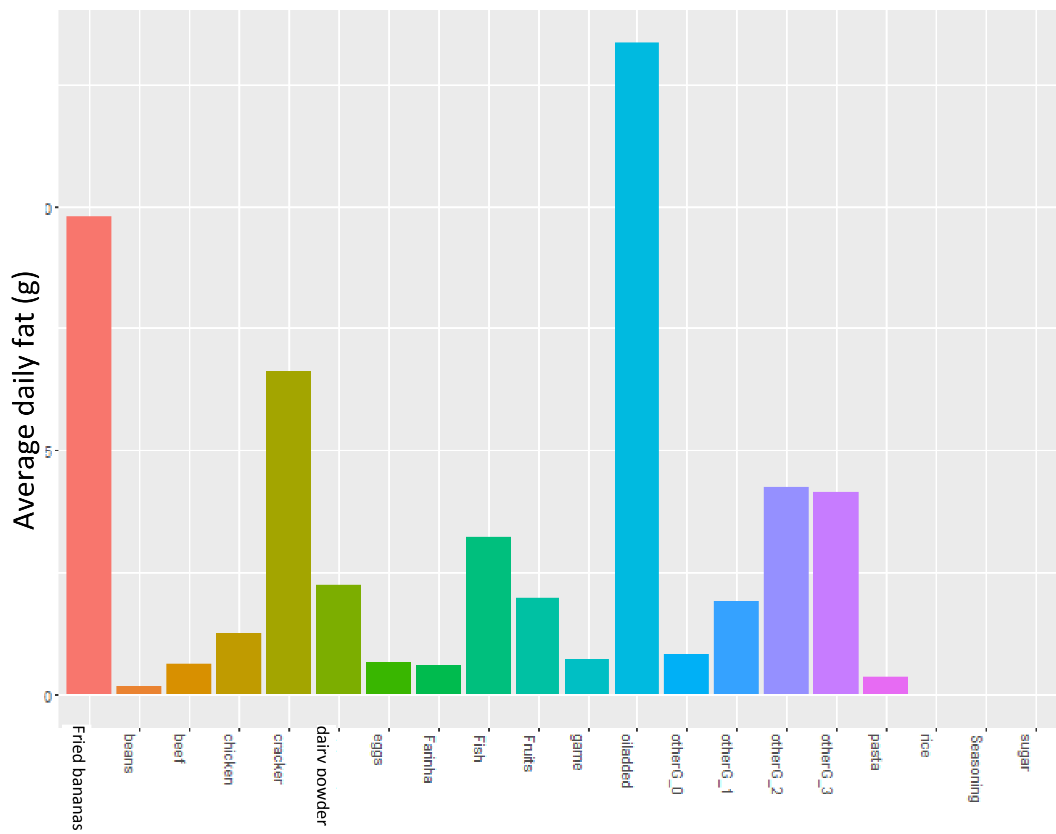


Figure 45. Average daily fat intake by food type for male adolescents.

Considering the average contributions across seasons, the main foods responsible for fat intake varied from vegetable oil added to dishes, fried bananas, and crackers, while others seem to play a minor role in terms of providing high quantities of fats in diets (Table 36). From this descriptive analysis crackers seem to be more important as a source of fat intake for male adolescent's diets across seasons compared to diets of female adolescent's and mothers.

Table 36. Food item average contributions and average percentage of total fat intake.

Rainy Season (N= 28 recalls)			**Dry Season (N= 24 recalls)**			**Transition Season (N= 14 recalls)**		
Food items (g)	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*	*Food item (g)*	*Mean*	*% intake*
Fried bananas	13.9	28.4%	Oil added	19.9	34.3%	Oil added	19.1	36.7%
Crackers	7.4	15.2%	Fried bananas	6.4	11%	Fried bananas	7.5	14.4%
Oil added	4.9	10%	Crackers	6.1	10.6%	Crackers	5.9	11.4%
Other group 2 foods	4.4	9.1%	Other group 1 foods	4.4	7.7%	Other group 2 foods	4.8	8.6%
Other group 3 foods	4.4	9%	Other group 3 foods	4.4	7.7%	Other group 3 foods	3.1	6.0%
Fruits	3.6	7.3%	Other group 2 foods	3.9	6.8%	Dairy powder	2.5	4.9%
Fish	3.4	6.9%	Fish	3.5	6.1%	Fish	2.4	4.7%
Dairy Powder	1.7	3.6%	Dairy Powder	2.6	4.6%	Other group 0 foods	1.7	3.3%
Chicken	1.3	2.6%	Eggs	1.6	2.8%	Chicken	1.6	3.1%
Beef	0.9	1.8%	Game	1	1.8%	Fruits	1.1	2.1%
Farinha	0.8	1.7%	Chicken	1	1.8%	Other group 1 foods	0.9	1.8%
Other group 0 foods	0.6	1.3%	Fruits	0.7	1.2%	Game	0.7	1.4%
Game	0.5	1%	Farinha	0.5	0.9%	Beef	0.4	0.8%
Pasta	0.3	0.7%	Other group 0 foods	0.5	0.9%	Farinha	0.2	0.4%
Beans	0.2	0.5%	Pasta	0.5	0.9%	Beans	0.1	0.3%
All others	0.4	0.9%	All others	0.5	0.8%	All others	0.1	0.3%
Total Kcal	48.8			57.9			52.2	

Again, the values for grams of fat from fruits per day were concentrated mostly on zero and one grams (Figure 46).

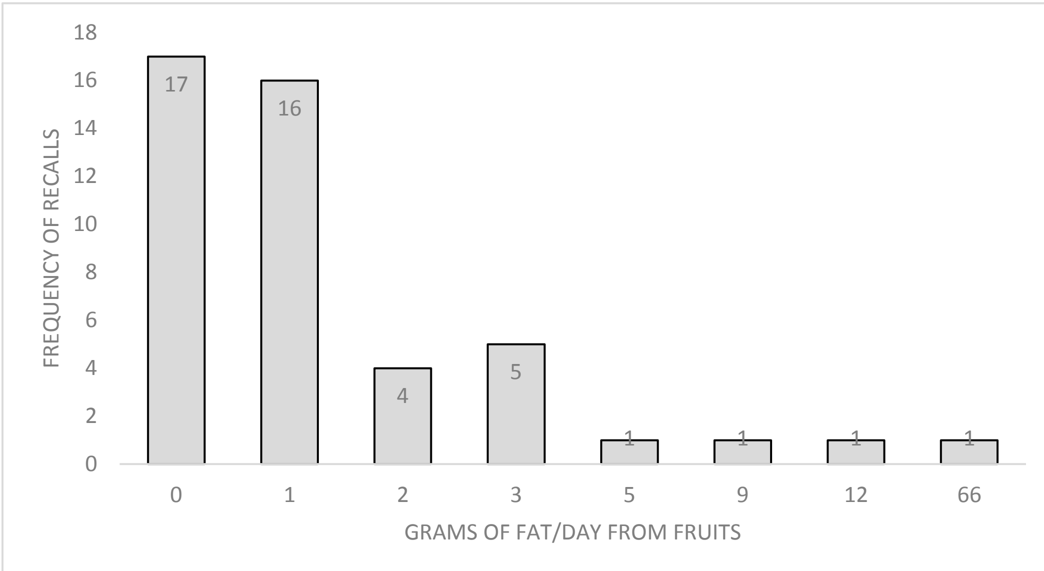


Figure 46. Fat intake from fruit in adolescent dietary recalls (g/day).

Considering each food type, as outlined in the analysis section, the linear mixed model below was used to estimate the effect of seasons on fat intake by food type:

Log daily fat intake (specific food item/category) = season + height + (1|id) [q]

The estimates for each model are reported in Table 37. Despite the lack of significant differences in fat intake between seasons in general, based on adolescent male's dietary recalls, daily fat intake from vegetable oil added to dishes, and other highly industrialized foods (group 3) was significantly higher in the dry season compared to the rainy season. Conversely, there was a higher fat intake from crackers in the dry season compared to the rainy season. Table 38 summarizes the results.

[q] (1|id) assumes random effects by participant, meaning that the model adopts different intercepts for each participant, accounting for repeated recalls with the same participants.

Table 37. LMM results for selected fat rich foods in adolescent male dietary recalls.

Fixed Effects Model	Rainy Season	Dry Season		Transition Season	
		Estimate	%Δ	*Estimate*	%Δ
Oil added to dishes	Ref.	0.94 (2.51)*	**155.72**	0.38 (0.88)	46.76
Fried bananas	Ref.	0.31 (0.67)	36.65	-0.93 (-1.61)	-60.6
Crackers	Ref.	-0.56 (-2.65)*	**-42.67**	-0.4 (-1.58)	-32.97
Fish	Ref.	0.02 (0.11)	24.87	-0.28 (-1.1)	-24.84
Other group 3 foods	Ref.	0.6 (2) .	**83.28**	0 (0)	-0.29

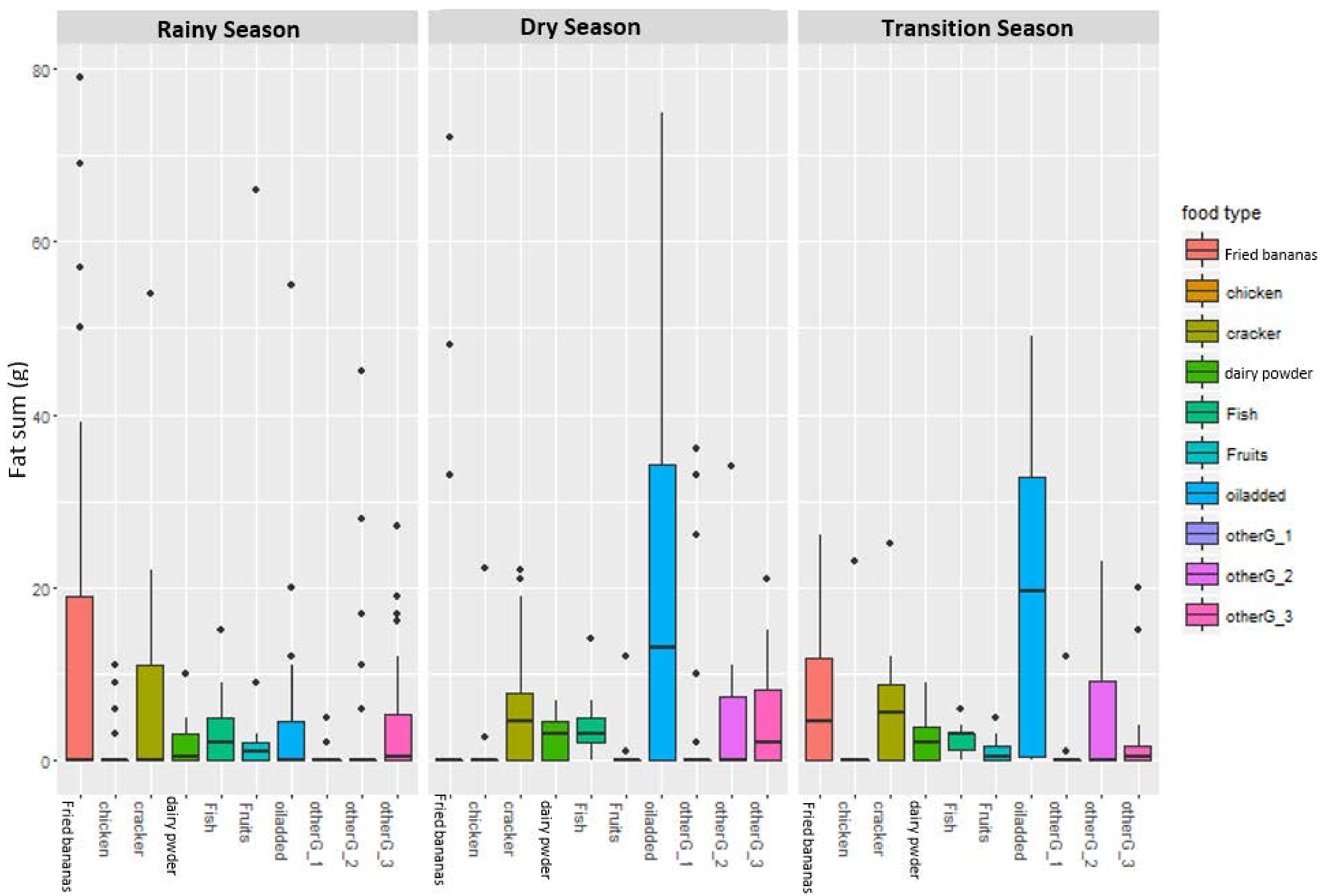
t statistics of each model in parenthesis, N=48, 10 participants, ***p<0.001, **p<0.01, *p<0.05, . p<0.1

In sum, for adolescent males, there was a higher daily fat intake from crackers was observed in the rainy season, whereas vegetable oil added to dishes and other highly industrialized foods (group 3) contributed with more grams of fat in diets daily in the dry season compared to the rainy season.

Table 38. Summary of differences in daily fat contribution of foods across seasons.

Average daily fat intake	Compared to dry season*
Higher in rainy season	Crackers (43%)
Lower in rainy season	Oil added to dishes (156%), other group 3 foods (83%)
No difference from rainy season	Fried bananas and fish
Excluded from model: no fat, predominantly low fat content foods, or low serving size	Sugar, seasonings, rice, other group 2 foods, other group 0 foods, farinha, pasta, rice, dairy powder, and fruits
Excluded from model: sample size lower than 4 recalls in each season	Chicken, eggs, game, beans, and beef

Figure 47. Daily fat intake (g) per selected food types across seasons for adolescent males.



RATES OF PARASITIC INFECTIONS

A total of 35 mothers, 11 adolescent females, and 8 adolescent males in the sample were tested for intestinal parasitological infection in the three communities studied. The most common infection was by the helminth *Ascaris lumbricoides* among all participants (Table 39). Although present, frequency of infection by other helminths tested (*Trichiuris trichiura, Ancylostoma duodenale, Strongyloides stercoralis,* and *Enterobius vermiculares*) was lower among participants. Evidence of protozoan *Amoeba histolytica* was detected in 51.4% of the samples collected from mothers, and frequency was lower for adolescent females and males (27.3 and 12.5 respectively). Signs of Infection by protozoan *Giardia lamblia* were particularly higher in stool samples of female adolescents compared to mothers and adolescent males. This pattern might be linked to different daily activities associated with age and gender, in which contamination might be more frequent. In general, there was a high frequency of infestation, and no samples were free of signs of intestinal parasites, despite the high rate of false negatives expected in direct methods of analysis, usually due to low parasite densities (Paugam et al. 2016).

Table 39. Percentage of samples infected with parasites for all participants.

Parasite	**Mothers**		**Adolescent females**		**Adolescent males**	
	N	*%*	*N*	*%*	*N*	*%*
Ascaris lumbricoides	21	60	6	54.5	4	50
Trichiuris trichiura	4	11.4	1	9.1	0	0
Ancylostoma duodenale	2	5.7	0	0	1	12.5
Strongiloides stercoralis	1	2.9	0	0	0	0
Enterobius vemicularis	1	2.9	0	0	1	12.5
Entamoeba histolytica	18	51.4	3	27.3	1	12.5
Giardia lamblia	3	8.6	5	45.5	1	12.5
Endolimax nana	4	11.4	1	9.1	0	0
At least one parasite	35	100	11	100	8	100
Multiple parasites	17	48.6	4	36.4	0	0
Total	35		11		8	

The results for the smaller sample of mothers and adolescents who participated in the detailed dietary data collection mirror the percentages reported above. In 15 out of the 35 mothers sampled also for dietary intake, multiple parasites were present in 7 (46.7%). For 3 of 8 female adolescents (37.5%) who participated in both dietary recalls and parasitic infections data collections multiple parasites were present, and the same percentage of female adolescents with a Giardia infection. For the 7 male adolescents who participated in both data collections, there were evidently no cases of infections by multiple parasites, and 1 case of infection by Giardia.

DISCUSSION

As outlined in the methods section, the specific objectives of this chapter, are: 1. to describe the cuisine and diets of mothers and adolescents living in Amanã; 2. to analyze the influence of environmental seasonality on the diets of mothers and adolescents; 3. to present results about intestinal parasitic infections; and 4. to contextualize the effects of seasonality in diets from a social and cultural perspective. In light of key results derived from the first three specific objectives, here I focus on discussing the fourth specific objective.

The challenge of this discussion is to assemble the results detailed in previous sections, contextualizing the main characteristics of the cuisine, dietary intake fluctuations, as well as parasitic infection data for women and adolescents living in Amanã. In doing so, with the purpose of understanding dietary adequacy and health among different age and gender groups, I offer three main arguments. First, I argue that there is a persistence in the farinha-fish complex as the core item in people's diets. Second, I suggest that adolescent females and women are a more vulnerable group in terms of their health status, compared to adolescent males, given their parasitic loads and the observed seasonal effects on their diets. Lastly, I allude to clues of a generational change in diet composition, showing that the persistent dietary core might not be all that persistent for adolescents, with energy and protein contributions of highly industrialized foods appearing to be much higher than that of adult women.

FARINHA-FISH COMPLEX

The most outstanding characteristic of the diets of Amanã residents is the great importance of the farinha-fish complex, central to macronutrient intake, the first as the principal contributor of kilocalories and the second by far the most significant source of proteins in diets. The energy intake average contribution of farinha for all age and gender groups in this study was similar to results presented in the literature of rural communities in the state of Pará. In Ituqui, Murrieta and Dufour (2004) reported farinha (including other manioc products) accounting for about 29.6% of the total energy consumption, combining both the rainy and dry season, considering data from adults and adolescents older than 15 years old. Here, combining seasons and all participant's data, farinha alone represented a 27.3% of the total energy intake. Bearing in mind the difference of almost 10 years in data collection, it is surprising that results on the energy contribution of farinha are so similar between Ituqui and Amanã. These results reinforce the idea of resilience of farinha in diets of rural Amazonians, and its status as an acquired taste and a symbol of resistance (Murrieta 2001; Adams 2002; Adams et al. 2009).

As discussed previously, the historical, social and cultural importance of manioc in the livelihoods and everyday practices of residents of Amanã cannot be overstated. Farinha is completely integrated in Amanã culture, illustrated by how manioc varieties are intertwined in the memories of families, and reproduced in the formation of new households (Lima 2005), as well as embedded in a complex system of production and long term agrobiodiversity enrichment (Viana, Steward, and Richers 2016; Rognant and Steward 2015). There were several accounts of male and female adolescents about manioc production, processing and consumption, inside and outside the household. Some of these accounts from adolescents are presented in chapter 1. A quote from a mother illustrates how the consumption of farinha is tied to the identity of the people born in the state of Amazonas:

> *"Farinha causes much harm, gives one worms. If we could avoid it (we would), but being from Amazonas, there is no way"* (Leide, 5/10/2014)
>
> *"A farinha prejudica muito, dá verme. Se a gente pudesse evitar (evitaria), mas sendo amazonense não dá"* (in Portuguese)

As mentioned in the quote above, it was common for people to link the consumption of farinha with parasitic infections in general, as well as to gastritis and *tuxina*, the latter a term for referring to *Trichiuris trichiura* infections, as explained to me later by an experienced health worker in the region. While the lack of environmental sanitation services is the most crucial root cause of the high rates of parasitic infections (Silva 2009), I suspect that some aspects of consumption and storage are linked to why people view farinha as the source of these infections. For example, sharing a bowl in which possibly dirty hands and utensils have been inserted multiple times, and frequently combining left over contaminated farinha with the stored bulk amount, may be part of the explanation.

During meals, each member would have an individual spoon and bowls with farinha would be placed nearby so that everyone was able to reach one easily. Spoons and hands would constantly go in the bowls, plates and mouths multiple times during a meal, as people initially put a good amount in their plates, but continued to eat small amounts of farinha at a time, such as half a spoon and handfuls from the bowls throughout a given meal. Once everyone is finished, the remaining farinha is put back in a larger storage metal bucket. Meals are eaten on the floor or at the table (where there was one), and small children would always eat on the floor and usually would share a farinha bowl of their own.

GENDERED VULNERABILITY: NUTRITIONAL FLUCTUATIONS AND PARASITISM

Rates of parasitic infections found at Amanã were exceptionally high and similar to other regions of the Amazon (Silva 2009). It was expected that this population would present lower rates of parasitic infections because of the history of development programs in the region, with the presence of the church and the Mamirauá Institute. Improvements in sanitation (septic tanks in a couple of households, access to water from a well in Santo Agostinho, and the presence of local health workers in Santo Agostinho and Nova Oeste) might not been sufficient to reduce rates of infections, especially by *Ascaris lumbricoides* and *Entamoeba hystolitica*, which in certain conditions can severely affect human health. Incidents of these two parasites were similar to studies looking at a number of different poor rural communities in the state of Pará (Silva 2009).

In light of the high rates of parasitic infections among adults and adolescents, the low average daily kilocalorie intake becomes further worrisome, particularly for adolescent females (refer to chapter 5 discussion section for potential methodological problems with regards to kilocalorie intake for mothers, in light of anthropometric results). Average results show most participants are consuming less kilocalories daily than recommended by international standards, and further nutrient absorption is compromised by intestinal parasitic infections. The high presence of infections in these communities is linked to a lack of sanitation mostly because resident's physiological necessities, as well as the washing of dishes and food processing, are all done in surrounding streams near the communities (in the rainy season) or by the river (in the dry season). Contamination in these areas is high, especially in the rainy season when there is no water current and waste from rudimentary latrines built behind houses rise along with the swelling river, accumulating all the polluted waste in a small area. Marcela, one of the adolescent girls participating in the photovoice activities, has an interesting account of this problem:

> *"I took this picture when my wit sister entered this hole. My mom told my brother to make it to use as our bathroom. He started digging but didn't finish because he had to go work in our fields. Before, our bathroom was further back, but here is hard to make it as the water reaches high, so we had to dismount it. In the flooding season, almost everyone runs to the toilet in our community center because others go underwater. I want my brother to finish soon because it's too bad to go use other's bathrooms. I'd rather have it closer to our house, on the dry land, but my dad doesn't have time to do it. This way if the bathroom got flooded, the house would too."* (Marcela's narrative for "The hole" photovoice)

Figure 48. Marcela's photovoice: "The hole."

Infections by giardia were three times more common in adolescent females compared to adolescent males and mothers, indicating these might be related to their daily activities. One possibility would be that these girls, especially in the rainy season, are constantly in contact with contaminated water when washing dishes and clothes for the whole household. In addition, rates of infections by multiple parasites were high for mothers and female adolescents (48.6 and 36.5% respectively) and were absent in male adolescents.

From the parasitic infections data combined with average daily kilocalorie consumption, data suggests health status of mothers and female adolescents are worse relative to male adolescents. Moreover, in terms of macronutrients in general, there was no significant variation in daily intake for male adolescents (Table 29), whereas mothers, on average, were consuming fewer carbohydrates and fat in the rainy season compared to the dry season (Table 5), and the same held true for fat intake in adolescent female diets (Table 17). The distribution of foods contributing to kilocalories in male adolescent's dietary data was also more consistent (Figure 42). Therefore, the data for women and adolescent females is aligned with a simplification of the staple food repertoire in the rainy season, reported previously in the literature (Murrieta and Dufour 2004; Murrieta et al. 2008; da Silva and Begossi 2009). However, results from this research indicate that this seasonal variation characterized as a simplification and kilocalorie instability may not be as significant in male adolescent's diets in this region.

In the rainy season, mothers are relying heavily on farinha, prepared fish and unprocessed foods (group 0), especially beiju and boiled manioc (34%, 12.5%, and 5.8% of the average daily intake respectively); whereas in the dry season, along with farinha and prepared fish, fried bananas appear as a key kilocalorie contributor (10.8% of the average daily intake). This pattern is counterintuitive given that researchers have previously reported a higher reliance on vegetable oils during the rainy season (Murrieta and Dufour 2004). In this case, fat intake in mother's diets are significantly higher from mixed recipes cooked at home, largely accounted for by fried manioc (on average fat intake from group 1 foods was 1.2 times higher – 120% - in the dry season, compared to the rainy season) as well as vegetable oil in the form of fried bananas (56% more Kcal on average in the dry season, compared to the rainy season). An even higher contribution was found for adolescent females who were consuming almost 15 times more kilocalories per day on average from fried bananas in the dry season, compared to the rainy season.

Fried bananas are consumed as a snack and it was extremely common to be served at breakfast or as an afternoon snack, and when a guest would stop by a household and the family happened to have bananas to offer. Usually they were served as banana chips, from fried green plantains, but sometimes ripe bananas were also served fried, with a soggy texture (for children, farinha would be served on the side for dunking the soggy fried banana, giving it a crunchy texture). Fried bananas were most commonly consumed in the household, but occasionally people would take them to the manioc fields. I did not witness people taking it when fishing, perhaps because of the nature of the activity, either because it would be a quick inspection of a fish net (*malhadeira*), or because it required silence, or a lack of space in a small canoe. There is also a photo voice account by a Sara, presented in chapter 1, of her frying bananas for her father who, according to her, was arriving tired and hungry from a fishing trip.

During fieldwork, I also observed that female adolescents who enjoy and thrive in activities outside the household, such as harvesting fruits and hunting small animals with traps, may suffer from prejudice because these are perceived as male roles. For instance, this was the case for Sara, a 12-year-old girl in this community who was constantly being harassed and faced great stress in her social relations at home and at school. In the household, as the oldest daughter, she carried the responsibility of taking care of four siblings and all household activities, while her parents, Cintia and Eusébio, had no salaried jobs, and worked in the manioc fields, as well as in basketry. This was a common reality for adolescent females in the community, although this particular family was especially large. Household work performed by young females was probably more common in past generations when the number of family members was even greater. Predictably, adolescent females were much less knowledgeable when it came to fishing activities. This required time and practice (boys practiced it constantly, whenever they could, at very young age) and was complex given the various techniques used. A few mothers would go fishing, mostly using a fish net or *caniço* (fishing pole made from a reed), sometimes accompanied by a young son, especially when no other adult male figure was present in the household.

As observed in the diets of mothers and adolescent females, a higher consumption of vegetable oil in the dry season was also found in adolescent males' diets, however, in the form of this ingredient added to animal protein dishes. The same was observed for adolescent females, in addition to the higher consumption of fried bananas discussed above. The average difference in fat intake per day from added vegetable oil to animal protein dishes was higher among adolescent males than among adolescent females, but in both cases adolescents were consuming on average more than double the fat from vegetable oil in the dry season compared to the rainy season (Table 22 and Table 34). In the case of adolescent males however, there was no difference in fat consumption overall across seasons (Table 29). This is accounted for by a significantly higher consumption of crackers in the rainy season (43% more fat intake on average) and other foods from which fat intake was not statistically different, nevertheless higher, such as with highly industrialized foods and fatty fruits (Table 37).

Moreover, in the dry season adolescent males continued to rely just as much on prepared fish as a source of kilocalories in their diets. No change was observed in the contribution of prepared fish in average daily intake of male adolescents between the rainy and dry season (8.4% of total intake for both seasons). For adolescent females and mothers, there was a significant decrease of 52% and 23% in the contribution of prepared fish to daily kilocalorie intake between the rainy and dry seasons respectively (4.3% and 4.2% of total energy intake). This data suggests adolescent males may have more control over the amount of fish they consume throughout the year, which some of my fieldwork observations illustrate. For instance, once I accompanied an 11-year-old who caught more than 17 fish in an hour and a half using a harpoon in a tiny canoe around the community. Also, I witnessed on three occasions male adolescents grilling fish in remote areas around the communities alone, and adolescent females would indicate to me where they were hiding. Moreover, when I stayed with a family of only four, a couple, Vera and Cleiton, who had two children, Gerson, a 13-year-old boy and Rosa, a 7-year-old girl, Gerson would frequently tell me I should eat as many *pacus* as I wanted because of the abundance in the river:

> "There is a ton of fish in this river" (Gerson, 8/5/2014)
>
> *"Tem rola de peixe nesse rio"* (In Portuguese)

I observed large amounts of leftover fish during the 10 days I spent living in the household mentioned above, which was sometimes sent to other households, sometimes fed to the pig, and often simply thrown out. Gerson was a very skillful fisherman, and he produced two photovoice pieces related to fishing, found in chapter 1. Cleiton, his father, was one of the only adult men who would identify himself as a fisherman in the communities, since he would fish for consumption and trade throughout the year. Most men living in these communities would only fish to provide for the household and during the Pirarucu fishing season in October - November.

In terms of protein intake from fish, there was no statistical difference across seasons for mothers and adolescent females and males. This pattern was different from the higher fish consumption in the dry season, overwhelmingly reported in other rural regions of the Amazon (Moran 1991; Murrieta et al. 2008; da Silva and Begossi 2009). In fact, from a descriptive perspective, fish consumption was higher in the rainy season. In the apex of the rainy season, in June, some residents would not report a decrease in fish, but say it was a good time for fishing with a caniço and in particular places because at this time fish “don’t swim much and hide under plants.” Possible reasons for this difference could be the dynamics of available stocks in this region given the presence and management of black water lakes, the particularities of fishing techniques most commonly used, or perhaps just an atypical year for consumption.

Nonetheless, similar to other authors’ results (e.g. Murrieta and Dufour 2004), fish was by far the most important source of protein in diets independent of the season, representing between 50% and 70% of the total protein intake. One exception, however, was observed in the diets of adolescent females in the transition season, in which fish accounted for 37.5% of the total protein intake. Moreover, for female and male adolescents, fish presented a somewhat minor role as a kilocalorie contributor compared to previous diets studied. (Piperata et al. 2011) reported a less important fish contribution to protein intake (30 – 40% of total intake); however, game contribution was also significant in their work, diverging from the results found here.

GENERATIONAL CHANGE IN CONSUMPTION: HIGHLY INDUSTRIALIZED FOODS

In Amanã, a surprising contributor to kilocalorie intake in the diets of male and female adolescents across seasons was highly industrialized foods (previously identified as group 3 foods in this study). While these items contributed with less than 4% of the average daily intake of mothers across seasons, they were among the top 4 kilocalorie contributors in the diets of adolescents, reaching 15.2% of the average daily intake in adolescent females’ diets during the rainy season. Highly industrialized foods contributed with more kilocalories than prepared fish across seasons for adolescents, presenting empirical data for a generational and perhaps income-linked diet change phenomenon. The most common items in this group were cookies, ice pops, and sausages, the latter two sold by one of the households in the community who had a diesel generator (both adults living in this household were school teachers). In terms of protein intake, combining seasons, these items contributed to a larger extent in the diets of adolescent females (8% of total protein intake), compared to adolescent males and mothers (5.2% and 4.6% respectively).

The rise in consumption of frozen chicken, has also been presented in the literature on diets in the Amazon, especially in urban areas (Nardoto et al. 2011; van Vliet et al. 2015). These were not significant sources of kilocalories in the diets of Amanã residents, and while present, contributed with a low percentage of the total energy intake compared to main staples and to previous results from research in other regions (e.g. Murrieta and Dufour 2004). In terms of protein sources, fish was overwhelmingly the most important source in diets, followed by either highly industrialized foods, accounted for by fried or boiled sausages, and farinha, the latter because of the large amounts eaten daily. Results show that chicken, eggs, game and beans played a minor role in contributing to their protein intake across seasons for all participants.

The significant presence of these industrialized foods in the diets of adolescents is an indication of the “bologna effect” recently depicted in the Brazilian media based on various articles published by Barbara Piperata (Folha de São Paulo 2016). She reported a change in health status in adult women living in rural areas of Pará, around the Caxiuanã National Forest between 2002 and 2009. These included a rise in the consumption of vegetable oil and crackers (which included breads and cookies) and a decrease in fish consumption (Piperata et al. 2011).

In the case of this research, this “industrialized foods effect” is presented as generational, given that a high kilocalorie contribution of items such as sausages, cookies, corn puffs, and ice pops were less present in the diets of mothers, and more noticeable in the diets of adolescents, independent of gender. Indeed, in terms of total protein intake, there is some indication that sausages and canned meats are more important than chicken, eggs or game, even though they represent only about 5% of the total protein intake for mothers and adolescents. The higher energy and protein contribution of these highly industrialized foods in adolescent female’s diets, combined with findings from dietary analysis and intestinal parasitic infections exposed above shows how this group may be more vulnerable regarding their health status in the social, environmental, and cultural context of Amanã.

CONCLUSIONS

The sparse data on food composition of Amazonian diets limits the analysis of the health status of this population and the study of its implications to human biology (Adams and Piperata 2014; Dufour et al. 2016). This study gives a detailed description of diets of residents of the Amanã Reserve located in the Middle Solimões, adding to the anthropological literature on cuisine and diets in the region. Many characteristics of the cuisine and diets presented here corroborate recent and past research conducted with indigenous groups and caboclo populations: farinha is the core food item in the diet and main energy source, and fish is the key source of protein. Few results were different from expected, including seasonal sources of protein intake, with a slightly higher fish consumption in the rainy season compared to the dry season. Nevertheless, data on protein intake was higher than the recommended values, and the rainy season was characterized as a period of kilocalorie intake instability, similar to the documented literature.

Many recent articles addressed the effects of a nutrition transition in the diets of rural and urban populations in the Amazon, mostly using anthropometric methods to asses a rise in obesity and shifts in diets (Piperata 2007; Lourenço et al. 2008; Piperata et al. 2011). The mechanisms of the so called “nutrition transition” in the context of the rural Amazon are still poorly understood, but attempts have been made to understand the effects of market integration and the effect of governmental policies (Coimbra Jr. et al. 2004; Piperata 2007; Piperata et al. 2011; Silva et al. 2016). In terms of health and nutrition, as posed by (Dufour et al. 2016), one of the most important questions to be addressed is how these changes are affecting dietary adequacy during vulnerable stages of the life course. Previous studies using this perspective are sparse, nonetheless they provided valuable information about contexts of inadequate kilocalorie intake for women during lactation (Piperata and Dufour 2007) that can compromise child growth and the mechanisms mothers use to compensate for shortages in their children’s own kilocalorie intake (Piperata et al. 2013).

Because adolescence is characterized by a period of intense physical growth, increase in nutrient need, and psychological development, research on health status of this group should receive more attention in Amazonian research. The study of human development in adolescence, however, entails complications given the high variability of sexual maturity and growth spurt, even among healthy individuals (Stang and Story 2005). Adolescence is a period of many biological changes in human development depending on internal variables such as disease and nutrition, as well as external factors such as stress in the household (Steinberg and Morris 2001; Youngblade et al. 2007).

Despite the limitations, findings of this study regarding seasonal food consumption reinforced prior studies indicating a nutritional transition more strongly among adolescents, specifically documenting a high contribution of vegetable oils and highly industrialized foods in their diets. Moreover, relative to male adolescents, findings indicate that adolescent females in particular may be more vulnerable to seasonal changes in terms of experiencing fluctuations in diets combined with rates of parasitic infections in the context of rural communities in Amanã. Further chapters elaborate on this argument, documenting the consumption of purchased and produced items (chapter 4), as well as evaluating health status and development based on anthropometric data (chapter 6).

CHAPTER 3: BOLSA FAMÍLIA AND FOOD, WHAT ARE PEOPLE BUYING AND HOW ARE THEY MAKING DECISIONS?

HOW MARIA DECIDED TO USE HER BOLSA FAMÍLIA MONEY

In this chapter, I use theories from anthropology, sociology, economics, and gender studies to investigate household money management with a focus on the meanings attached to the Bolsa Família Program (BFP) cash benefit. Using ethnography, in-depth interviews, and surveys, I look at how women in the rural Middle Solimões region perceive the BFP by identifying discourses around how the BFP benefit should be spent, as well as through accounts of their actions and money expenditure.

When I first arrived in the Santo Agostinho, I participated in one of their meetings to talk about my research and obtain their consent. Upon learning about the project, they decided I could stay around and agreed to my proposal of rotating stays as a guest in each household willing to receive me (usually for 2 weeks at a time). This rotating system ended up working well for the first two months in which they decided I should stay in the "best" houses that had mattresses and some kind of indoor bathroom structure. It took some time for me to convince people that I would be just fine in houses without an indoor bathroom, and that it was reasonable for me to sleep in a hammock like almost everyone else. Later on, I ended up managing to stay in some of the poorest households, where people accepted my presence. This happened only in the households of women with whom I developed a very close relationship.

During that time in which I was building rapport and showing people I didn't care about toilets or mattresses (this was especially true for the latter, as I slept far more comfortably in hammocks), I mostly stayed with Vania, who lived with her granddaughter Diana (Conceição's daughter) in a house built of cement; most others were made of wood. I spent long hours talking to Vania, who had a fascinating story and knew a lot about the history of that place. Vania gave birth to nine children, three of them died at young age. One got sick as a baby and died, the other two were twins: two girls with curly light hair who died around age 5 in the hospital, most probably from pneumonia. Vania had a very difficult life, everyone in the community recognized it. They would talk about the hours she used to spend in the manioc fields across the river when her husband was travelling selling crops, and how she never complained.

Vania was very proud that all of her children finished high school (she spent a few years living at a Catholic mission so that her children could attend secondary school), and she used to tell me: "The only reasons for Maria not to be a teacher is because she doesn't want to be. " Indeed, she had two daughters living in the nearest town who were teachers. Her two daughters living in the community, Maria and Conceição did not pursue a teaching career after finishing school, but her son, Dito, who also lived in the community, was a local teacher and was pursuing his undergraduate degree while attending university in the nearest town for two months per year. I briefly met her older son who spent a week in her house during the community party. He is a truck driver and owns his own truck.

In this introduction, I offer a few quotes and accounts from Maria, Vania's daughter. These quotes and accounts touch on the essence of this chapter, showing how women feel about the BFP benefit, as well as how the household context, especially in terms of members' needs and aspirations, shapes the way women decide how to use their benefit. Maria is married to Jairo and has two daughters from previous relationships, Samia and Soraia, and two daughters with Jairo, Lorena and Lidia. Her four daughters live with them and are listed on Maria's Bolsa Família debit card.

From the first interview I conducted with Maria, we see she felt strongly about having control over the expenditure of the BFP benefit:

> "(…) there are some husbands who are like that, you know? They get the money [*referring to the BFP benefit*], and then it's mine, and I am going to take it [*pretending she is 'the husband'*]. Not on mine [*referring to the BFP benefit she receives*], because I know what is needed inside this house. If there is something missing, I go and I buy it."

Maria talked about her parents, Vania and Mario, with a lot of pride and with a sense that she had the obligation to help them later in life. For instance, Maria could not understand how someone like me, the same age as her and married, could not have any children. She would repeatedly say to me: "At least one, Aninha. Who is going to bring you a glass of water when you're old?" After we became good friends, Maria told many stories about how she grew up in the community, and the past encounters she had with prejudice against being a single mother, including sexual harassment by men in the community. She always emphasized how her parents supported her through these difficulties. Maria was very present in Vania's house too, mostly to check on her, including bringing food and cleaning. Vania was 71 and started to show signs of dementia while I was there.

Maria told me that when she started receiving the Bolsa Família she was not married to Jairo yet and still lived with Vania and Mario; her two children from her previous relationships, Samia and Soraia; and her niece, Diana. For more than a year before Mario died, Maria would willingly and religiously give all the money she received from her BFP benefit to him. Mario was a smoker and was very sick with cancer (he had already died when I first arrived in Santo Agostinho). Vania had Mario's lungs x-rayed tucked inside a wardrobe (uncommon in most households), and showed it to me several times so I could see the damage cigarettes can do to one's lungs. As Maria told me, when Mario started to get sick he would often repeat: "I won't die without being able to poop inside this house," referring to having a bathroom with indoors toilet, instead of an outhouse with a hole in the floor, like most other residents. According to Maria, Mario used the BFP benefit she gave him to buy materials and pay people in the community to help with building the bathroom. Indeed, they finished building it before he died. Maria enjoyed telling me this story, which she repeated multiple times with pride and joy, since it does have a funny twist, despite referring to her father's passing.

All of the households in which I actively interviewed women about using the BFP benefit were composed of a nuclear family, varying greatly in generational cycle: some with babies and others with young adults. In some cases, there were other family members visiting for extended periods of time, often weeks at a time, but that was surprisingly uncommon. When it happened, most visitors were adult sons or daughters from the nuclear family couple. Here I address household decisions made in the current context for most households in the communities studied, but Maria's account above reflects aspirations from her past, when her father was alive. She was the only child who still lived with her parents; Lorena and Lidia, the two daughters she had with Jairo, had not yet been born. Now she has her own house, one of the farthest from the river, as it has been recently built. In this new family arrangement, Maria's aspirations are different from when she lived with her parents, as is her expenditure of the BFP benefit.

Maria's story shows how anthropology can illuminate an understanding of the dynamics between food security and women's autonomy resulting from a cash transfer program. In this chapter, I use an anthropological approach to investigate what happens in a rural Amazonian household once the BFP benefit is received, by analyzing the control over money expenditure and food provisioning within households. I concur with the premise that BFP effects are dependent on context, systematically assessing (1) how money is managed in the household, (2) if the BFP benefit is considered special purpose money, (3) if its expenditure is directly related to food purchase, and (4) if the type of management and control over the benefit varies according to household income and items purchased. I start with a background of the Bolsa Familia Program (BFP) and a review of the literature on household money management and its intersections with Conditional Cash Transfer Programs (CCTs).

BACKGROUND: THE BOLSA FAMÍLIA CONDITIONAL CASH TRANSFER PROGRAM

In Latin America, CCT policies were received with great anticipation, conceived as a strategy to address poverty, food insecurity, education, health and gender inequality. The BFP is frequently used to exemplify this success (Lindert et al. 2007; Lomelí 2008; FAO 2015). The BFP evolved from regional initiatives, taking its present form in 2003 under a framework of hunger eradication. Essentially, the program consists of direct money transfers from the national government to families in extreme poverty, based upon their compliance with certain child education and health conditions. The program also provides cash transfers to extremely poor families with no children.

In the case of the BFP and of other CCTs in Latin America, strengths and weaknesses have been discussed in the literature. There is a large body of evidence showing that CCTs lead to increases in the use of education and health services, access to consumer goods (Basset 2008; Hoddinott 2010), and women's empowerment and autonomy (Rocha and Latapí 2009; Rego and Pinzani 2014). In contrast, critics highlight the inefficient supply of services necessary for compliance, errors in eligibility criteria (Hall 2006), and limitations on gender equity promotion, suggesting that CCT can disincentivize women to enter the job market by reinforcing traditional gender roles (Molyneux and Thomson 2011). Some research demonstrates no significant improvement in children's nutritional status (Manley, Gitter, and Slavchevska 2013).

In rural communities in Brazil's Amazonas state, children have historically suffered from chronic malnutrition (Alencar et al. 2007). Work by (Piperata et al. 2011) in Amazonian inland communities in the state of Pará looked at sources of family income, asserting that the BFP was the "most noticeable change to household income discussed by local people" (Piperata et al. 2011: 460). Also, retirement benefits and the BFP benefit were identified as the most significant part of household income in Middle Solimões communities (Peralta and Lima 2014).

The name Bolsa Família program can be translated as "family allowance program". The word *bolsa* has a double meaning in Portuguese, either as a "bag" like in English (purse, backpack or a plastic grocery bag); or as "allowance" or "scholarship. " Beneficiaries are eligible if their monthly household income is lower than 77 *reais* per capita (approximately $24USD, or extremely poor) or above 77 reais but below 154 per capita (approximately $49USD, or poor), [18] and they comply with childhood education and health conditions (when children are present).

[18] Figure during most of the time that the research was conducted, changed from 70 BRL to 77 BRL per capita in May of 2014 (Decreto 8.794 2016). The most recent change considers extreme poverty in households with less than 85 BRL per capita.

These households receive a debit card and a pin number, and the benefit can be withdrawn every month as cash. There is no directive on the use of money so long as these households continue in the same income bracket, and their children attend school and receive necessary vaccinations

The BFP was created in 2003 and consolidated under law number 10.836. It is managed by the federal government but municipalities are responsible for its implementation and data collection. A total of 13.7 million families, almost a quarter of the Brazilian population, received an average of 167.8 reais (equivalent to $52.6 USD) in June 2015 (MDS 2015). Currently there are six categories of benefits calculated based on household income per capita, age of members, and presence of pregnant or lactating women. Also, according to the law, payments are made “preferably to the woman,” (Casa Civil 2004) without specification about exceptions, inferring that municipalities have discretion regarding whose name will appear on the card.

HOUSEHOLD MONEY MANAGEMENT: BOLSA FAMILIA IN DECISION MAKING

In this chapter, the household is used as the unit of analysis because of the importance of looking at decision making at this level. The household is defined as the core of economic and social relationships among its members. By contextualizing household money management theories and models proposed in anthropology and in other disciplines, anthropologists are equipped with the tools to test them under the scrutiny of everyday life. Models can be analyzed under the light of how much they fit into a particular socio-cultural environment, by decoding the allocation of resources in the household, and paying attention to negotiation mediated by particular cultural values (Ortiz 2012).

For instance, Wolf (1966)laid out a theoretical foundation for the study of peasants, defining them largely in economic terms, with the household occupying the center stage of decisions, although nested in broader power structures. The peasant household budget model was characterized as a series of obligated funds, with the overflow organized according to priorities (Wolf 1966). Building on that, (Wilk 1989) argues for the inclusion of control over the allocation of the resources according to household member's rights, which are determined by factors such as lineage, source of income, workload contribution and so forth. Based on empirical data collected among the Kekchi of Belize, (Wilk 1989) argues that members are willing to put extra effort into household activities when they have more say in managing the money, using a common pool fund; whereas central and patriarchal management often fund personal projects, which leads to less commitment from other members. In this case, members may have bargaining power in decisions by refusing or diminishing the time or amount of labor put into such projects.

Modelling household budgets according to modes of management and control over resources has shown to be instrumental in understanding decision making (i.e. (Acheson 1994; Kenney 2006; Carruthers 2010). (Wilk 1993) offers three general categories for modes of household money management: obligated, personal and general fund. *Obligated funds* are set aside for a specific allocation, such as food; *personal funds* are exclusively controlled by a household member; and *general funds* are resources without prior constraints, to be used in the future. These can be combined in terms of who controls the personal or pooled fund (e.g. woman or man), or the presence of partial pooling (Kenney 2006). These categories are directly connected to morals attached to different funds, which are linked to expenditure and outcomes that affect the household and its members. (Kenney 2006) for instance, suggests that personal money controlled by women in the household are more likely to be spent with children's needs in mind. She does, however, make the case that this varies according to how much each parent contributes in house chores and in earnings outside the household. She also stresses that her findings are restricted to "white heterosexual couples. " There are a few studies showing positive associations between women's control over household income or percentage of income earned by women and types of money expenditure in developing countries (e.g. Schmeer [2005] using survey data for Cebu in the Philippines, and Gummerson and Schneider [2013] for households in South Africa). Moreover, mother's management of household income have shown substantial importance for children's food security in Nicaragua (Schmeer et al. 2015).

The study of household decision making and budget modelling entails many methodological limitations, not only due to the difficulty of building rapport in order to study intimate household negotiations, but also in terms of definitions (e.g. in Wilk 1989; Kenney 2006; Chibnik 2011). For instance, Chibnik (2011) highlights the difficulty in delineating the household. In his fieldwork in the rural Amazon, Chibnik (2011) encountered resource pooling among more than one dwelling, partial pooling, and fluidity in the composition of households. On the other hand, he also recognizes the validity of critiques of studies that look at the household as a single entity, without evaluating internal relationships. For example, he reflects upon his fieldwork in Belize, concluding that he did not pay enough attention to women's control of resources. The separation of funds, either for a specific purpose or restricting control over expenditure, consists of "special money" (Zelizer 1989), especially in poor rural households, which have been predominantly described as pooling all funds. For instance, despite all problems Chibnik (2011) encountered in his fieldwork, he makes the case that "in all three places [referring to his fieldwork in Belize, the Peruvian Amazon, and Oaxaca], the household acted more or less as a group in many important economic decisions. "

From behavioral economics, prospect theory offers a promising predictive model for decision making under risk; however, there is little empirical testing and supporting evidence for its principles as a behavioral model for everyday life (Barberis 2013). This is a model with potential application in the context of decision making in poor households, especially when poverty is understood as a highly risky condition (Banerjee and Duflo 2012). The three main principles of prospect theory are:

i) "reference dependence" which assumes people derive utility from gains and losses relative to some point (changes are more important than absolute values);

ii) "loss aversion" predicting that individuals are more sensitive to losses than gains. Here, in theories of consumption, one might argue that gains get to the point of becoming meaningless to certain references, whereas losses are highly meaningful compared to references. In behavioral economics they call this "diminishing sensitivity"; and

iii) "overweighing" related to probability weighting, arguing that in risky situations people perceive a higher probability of extreme outcomes happening, so they have a tendency of emphasizing unlikely extreme outcomes in their decisions (Barberis 2013).

A promising element from prospect theory to be incorporated in the study of money management decisions in poor households is "reference dependence. " In this case, references may be tied to household member's control over allocation, as previously argued from scholars in anthropology and sociology (Wilk 1989; Zelizer 1989; Carruthers 2010), as well as their assets. From an asset ownership modelling of Latin American countries data, (Deere, Alvarado, and Twyman 2012) show how mapping individual member's assets in the household would better inform policies targeting poverty, by understanding internal inequalities in allocation, as well as distinguishing households trapped in chronic poverty from those possibilities of upward mobility. Additionally, Kőszegi and Rabin (2009) propose that the reference points are the expectations held in the recent past about the outcome, bringing in the necessity to incorporate experience and memory. In this sense, a source of steady income, such as a public policy for family cash transfers to poor households, acts on the expectations of receiving a monthly benefit, therefore being incorporated as part of the baseline.

From a historical perspective, (Zelizer 1989) shows how the state has always been interested in controlling people's money, especially household management for low-income classes. This is particularly important for this research as it investigates a CCT program managed by the federal government in Brazil. The BFP family cash transfers are made preferably to mothers, under the assumption that they "provide the means to increase food availability at the household level" (Hoddinot 2010: 237). CCTs originated under the notion that families in extreme poverty face higher risks of not meeting basic needs, being constantly hindered by uncertainties, and facing the impossibility of planning a household budget (Banerjee and Duflo 2012). However, one may argue that CCTs have been used as a "one solution saves all" in addressing poverty in any context. CCTs have spread to most of Latin America, covering millions of households in Mexico with the Oportunidades program and in Brazil with the Bolsa Familia. Moreover, it became a worldwide phenomenon, with a "CCT wave" spreading into Africa and Asia, as well, including in Kenya, Nigeria, and Bangladesh (Fiszbein et al. 2009). These programs were initially geared towards breaking the generational cycle of poverty, but have recently been implemented with diverse purposes and conditions, ranging from forest conservation conditional cash incentives such as the Bolsa Floresta (Börner et al. 2013), to changing risky sexual behavior in order to prevent the spread of HIV (Shetty 2011).

Banerjee and Duflo (2012) make a convincing case about the hazards of being poor, both based on their fieldwork in India and from the available literature, especially where it concerns small farmers. They show how bargaining models, in which household members efficiently make decisions on allocating funds, are hindered when members face high levels of stress from everyday uncertainties. These uncertainties are fluctuations in income due to job availability; extreme events linked to crop production failure, lack of food, and unaffordable quality health services; as well as exposure to political violence, crime, and corruption. They view CCTs as a promising model both as a means of directing resources to women, and by providing a steady income, which lessens the uncertainties faced in extremely poor households (Banerjee and Duflo 2012).

Modeling of household budgets does indicate that programs targeting marginalized groups have the potential to change the structure of the management of financial resources in the household (Haddad and Kanbur 1990). CCT programs rely on mothers to take up the responsibilities of fulfilling expectations from the conditionalities, and studies have shown that mothers do exercise more control in the household budget and feel “empowered,” and therefore gain status (Rocha and Latapí 2009; Rego and Pinzani 2014). In rural areas of the Brazilian northeast, (Duarte, Sampaio, and Sampaio 2009) show evidence that families participating in the BFP were, on a monthly average, spending more money on food (88% of the benefit) than non-participant families. In addition, at the country level, respondents in BFP-recipient households identified food as their main use of the benefit, followed by school materials and clothing for children (Ibase 2008). At the same time, CCT evaluations conducted in Peru, Bolivia, and Ecuador show that cash transfers raise women's responsibility in a context of deterioration of the social services (Molyneux 2002), as well as re-enforce the stigma of laziness, perceived by women in their interactions with service providers in clinics and banks (Molyneux and Thomson 2011).

The framing of programs such as the BFP by the organizations implementing them at the national, regional, and local levels is varied, and people in different contexts may understand its purpose in different ways. On the ground, people may have little understanding of how it actually works. Possible messages are that the BFP benefit is:

i) to be managed by the mother in the household, as the benefit is preferably transferred to them, and women should have their name printed on the card;
ii) to be used for purchase of food, as it was originated from a governmental platform designed to eradicate hunger;
iii) to be used for purchase of school materials and other necessary items in children and youth schooling, as the amount you receive is mostly conditional upon sending children to school, and the cash benefit increases with the number of children in the household (limited to a maximum of five); and
iv) to be used by pregnant women, youth or children, given that the benefit increases if these members are present in the household (the benefit is higher for 16 to 17-year-olds than for younger children).

As these framings and discourses reach the local level in different socio-cultural and historical contexts, they gain new meanings, and these are explored here. Here, I investigate household money management in communities located in the Amanã Sustainable Reserve. I look at general household money management, focusing on the management of the BFP. This includes the purposes attached to it, whether control over the expenditure of the benefit varies, and ultimately what is purchased with it.

METHODS

The aim of this research was to elucidate the dynamics of money management and BFP benefit usage from a food and gender perspective. I conducted census interviews, participant observation, and household money management interviews with women to address: (1) how money is managed in the household, (2) if the BFP benefit is considered special purpose money, (2) if the BFP benefit expenditure is directly related to food purchase, and (3) if the type of management and control over the BFP benefit varies according to household income and items purchased.

Household money management interviews were conducted in two phases (Table 40). In the first phase, 25 interviews were conducted, from August to October of 2014, and 27 were conducted in the second phase, in January and February 2015.

The interview guide was developed based on elements of an ethnographic interview (Spradley 1979). In phase one, I interviewed women about general money management in the household, investigating if they viewed the expenditure of the BFP benefit as separate from other household expenditures, and if there were rules for its use. I also asked women on how they usually spent the BFP benefit; then later, specifically about benefit use months prior to the interview. Based on coding of phase one interviews, I structured an interview guide and conducted a second interview with all available participants. These were meant to address any questions that were unclear from the first interview, and also to understand more fully their ideas about who should be responsible for food provisioning and purchase.

In total, 34 women were interviewed about money management in the household and the uses of the Bolsa Família benefit (Table 40), and 18 women participated in both phases. Considering that demographic variables, household composition, income, and productive activities are important for contextualizing findings related to intra-household money management, an initial household census (described in detail in Chapter 2), using a structured questionnaire, was conducted between February and March of 2014.

Moreover, participant observation in daily activities and in trips to town assisted with building rapport with community members and for interpreting interview results. Data analysis was conducted using MAXQDA 11 software for coding interviews and generating cross tabular comparisons. The relationship between variables was calculated using Analysis of Variance (ANOVA) or the Pearson's chi-square tests in R version 3.2.2 (R Core Team 2015). The ANOVA and chi-square calculations of post hoc statistical power were conducted using the "pwr" package (Champely et al. 2017). Levene's level test in the former was conducted using the "car" package (Fox et al. 2016), and the effect size in the latter was computed using the "vcd" package (Meyer et al. 2016).

Table 40. Household money management interviews samples by women's age group.

Age of interviewee	**20-34**	**35-54**	**Total**
Phase one	13	12	25
Phase two	15	13	27

The calculations of income were based on information from census interviews, participant observation, and triangulation with available governmental data. Data collection before the start of the school year proved to be limited in terms of evaluating income from surveys, given that many residents were hired afterwards. Primary information obtained in the census and interviews were triangulated with official public hiring documents specifying salaries[19], as well as federal governmental benefits details available through the portaltransparencia.gov.br and dataprev.gov.br websites.

Exact amounts of Bolsa Família and artisanal fishing benefits received in the year of 2014 by residents are public and were retrieved from the aforementioned website. For 14 people, data about the amounts received from the artisanal fishing benefits was available and retrieved from governmental sources. Because there was a minimum wage change during that period, some recipients received more than others. For the seven households that declared receiving the benefits but values were not found on the website, 4 months of the most common minimum wage value were considered as the benefit (4 times 724 BRL). Retirement benefits and pensions were calculated based on minimum wage data in the state of Amazonas. Moreover, most residents were also receiving a monthly state benefit from the Bolsa Floresta Program with a fixed value of 50 BRL, which was included in the income calculation for residents who confirmed participation.

Household income was calculated by adding values received from governmental benefits, as well as wage salaries. Social benefits and wages were used as proxies for income because they represent a steady cash flow and could be easily calculated and recorded. On the

[19] official documents of the town hall of Maraã municipality (EDITAL N° 01/2014)

contrary, income from agricultural production and fishing, as well as other income sources, such as occasional jobs in construction of houses or boats, fluctuate greatly (in terms of price and availability), and would require a data collection effort and respondent burden beyond the scope of this research. The use of social benefits and wages as proxies for income was based on the limitations of data collection, and on the literature of the region that emphasizes social benefits represent the most significant part of the household income (Peralta and Lima 2014).

Nevertheless, general information on production and commercialization of crops and livestock, as well as the most important perceived source of household income, were assessed during the census interviews. While this data was incorporated in the interpretation and discussion of results, monthly income per capita was calculated by adding governmental benefits and wage salaries received from all members, divided by the number of members who were living in the household for at least 6 months of the year.

In terms of family demography, there is a vast literature showing the importance of kinship in rural households in the Amazon, strongly tied to identity (e.g. (Lima 1992). Moreover, boundary issues may be especially problematic in defining members of a household, because intimate economic and social decisions may not necessarily occur within the same geographic residence (Chibnik 2011). Here I used the artifact of considering the time members spent living in a household, excluding “guests” who spent less than 6 months residing in a particular household during the observed period.

Unless noted otherwise, whenever I refer to the woman or man in the household, I consider the nuclear family as the living arrangement, characterized by at least a head of household couple, a man and a woman, who left their previous households after gaining some independence and thereafter formed a new household (Le Play and Emerson 1872). Because I am analyzing the effects of the BFP, I deliberately prioritized interviews in households where mothers and children were present. Moreover, I noted intergenerational co-residence and age composition in each household, as these are critical elements for analyzing household dynamics (Ruggles 2012).

RESULTS

HOUSEHOLD PROFILES

There were 48 households participating in the activities conducted during this research. In two, household members did not agree to participate in any of the research activities besides the first census interview (one traditional nuclear family with three young children, the other an older couple living with two grandsons). Four households were not classified as nuclear families, in two elderly men lived by themselves, in another one sister lived together with her four sons and left for town, visiting sporadically, and in the last one an elderly woman lived with her granddaughter. Moreover, one household had a couple with no children. None of the five households outlined above were part of the BFP program.

Of the families who formally agreed on participating in activities, one left the community during the first few months I arrived, in another the woman did not have time available alone, three women were pregnant for most of the time I was there and were not interviewed, and in the other two, women were travelling for long periods of time and I was unable to find a time to interview them.

The vast majority of the women interviewed were part of households characterized by a nuclear family with children younger than 18 (Table 41). In five of them grandchildren were present, and in eight there was some fluidity in members coming and going during the time I was there (e.g. babies born, one elderly woman who died, extended visits of children or other siblings of the mother, and adolescent daughters who left to form new households).

In the 34 households where interviews were conducted, the average number of members was six, with a range between three and nine. There were no single parent households, and adults living by themselves were excluded from the sample. The average number of children less than 18 years old was 3.2, ranging from zero to seven per household. The average age of women interviewed was 36, ranging from 20 to 54. Education levels varied greatly with women who had never attended school (six women), to those who were currently persuing an undergraduate degree (seven women). One woman finished her undergraduate degree and held a position as the local school coordinator.

Table 41. Summary demographic profile of sampled households

	Nuclear family				**One elderly member (living alone or with gradchild) or sisters living with children**	**Totals**
Children/grand-children (age)	*Only less than 18*	*Both less and more than 18*	*Only more than 18*	*Zero*		
Participated	27	7	0		0	34
Did not participate	9	0	0	1	4	14

Excluding activities such as agriculture, fishing, and sale of handicrafts and goods, steady sources of income were: teacher salaries, school job wages (janitors and food preparation with lower wages than teachers), one wage from a research facility caretaker for the Mamirauá Institute, health agent salaries, retirement, pensions either arising from poor health or a deceased spouse, and benefits from Bolsa Floresta and Bolsa Família cash-transfer programs. The artisanal fishing insurance is received by some households and was included in calculations, but cannot be considered as a steady income as it is paid once accounting for 4 months during which fishing is restricted by conservation policies. The species of fish and periods of restriction in the state of Amazonas are published yearly (Figure 49). At the time of the census collection, no participants were receiving governmental maternity benefits.

Of the 34 households participating in the BFP, only 2 did not receive Bolsa Floresta, a state policy providing monthy cash transfers of 50 BRL to families living inside a Sustainable Reserve. These 2 families did not receive the Bolsa Floresta benefit because of registration problems. Considering steady income sources only from wages, retirement, and pensions, of the 34 households, in 7 this type of income was doubled (in 3 of those both women and men were teachers, in 1 both women and men received illness pensions, in 1 a male teacher also received a pension, in 1 a woman received a death pension and an illness pension, and in one more an older son and an older daughter worked as teachers). In 17, one member received income from one of the steady sources listed above (eight women, four men, one older sons, two children with disabilities, and one child with developmental problems). In 10 households in the sample none of the steady sources of income outlined above were present.

Figure 49. Ministry of Fisheries poster with restrictions associated with artisanal fishing benefits

Santo Agostinho had a communal generator and had electricity for about three hours in the evening most week days. These three hours were when people who owned freezers turned them on and watched televison. This communal generator ran with diesel partly provided by the municipality for middle school evening classes, supplemented with money from each household. Some families had their own small generator at home for when they used electricity outside these times. Nova Oeste also had a communal generator, but there was no electricity in Vila Central and nearby localities. In Santo Agostinho, there was a water well and pipes connected to most houses, usually pumped once a day, which failed when collectively shared money precluded adequate gas. In the smaller communities, people relied on collecting rain water.

Income data from social benefits and wages was collected, as well as manioc flour commercialization, cattle and buffalo rearing, and the presence of household commerce. As pointed out in the previous section, agricultural production and other income from natural resource management activities were viewed as important, but were not quantified during fieldwork. The most important agricultural product commercialized by participants is manioc flour, and 62% (21/34) of households in this sample produced it. Commercialization of banana, açaí, watermelon, pineapple and other fruits and vegetables was present, but were lower in comparison with manioc flour. Fish commercialization was limited, and only two men in the community regularly sold fish in town or for local buyers. One exception is the pirarucu (*Arapaima gigas*) fishing season during October-November, in which most men in the community participated, as described in Chapter 1.

Considering income from wages and social benefits, the BFP represents a significant amount of the available cash in the household. For all households, the BFP represented, on average, 36.2% of the total income, ranging from 89.4% to 6.6%. The income profile of households shows evidence for 25 households in the sample to be above the income limit for participation in the BFP during the time of data collection (154BRL per capita). Table 42 includes only households where the BFP benefit mode of management interviews were conducted. Again, the calculated income accounts for amounts received from Artisanal Fishing Insurance (*seguro defeso*), retirement, and pensions either for disease or a deceased spouse, and family cash transfers from the Bolsa Floresta program.

Table 42. Economic profile of sampled households

Income per month per capita	**Less than 140 BRL[a]**	**Less than 250 BRL[b]**	**Less than 550 BRL[c]**
Average income per month per capita	108.2 BRL	203.8 BRL	347.7 BRL
Number of households	8	14	12
Average household size	6.5	6.2	4.6
Average BFP per month	401.70 BRL	447.89 BRL	265.74
Produces *farinha*	7/8 (87.5%)	8/14 (57.1%)	6/12 (50%)
Has cattle or buffalo	1/7	1/14	1/12
Has household commerce	0	1/14	2/12

[a] Data for 1 woman who was not interviewed about household money management decisions had average income per capita 78.8 BRL
[b] Data for 1 woman who was not interviewed about household money management decisions had average income per capita 142.6 BRL
[c] Data for 1 woman who was not interviewed about household money management decisions had average income per capita 464.1 BRL

With the purpose of describing the domestic economy in 2 reserves located in the Middle Solimões, including Amanã, Peralta and Lima (2014) analyzed 2011 recall data for 920 households, and concluded that social benefits were the most important contributor to monetary income. At Amanã alone, social benefits contributed on average 43.2% to the overall household income, with wages at 15.7% (Peralta and Lima, 2014). Given that Santo Agostinho, studied in this research, had a large number of residents relative to other communities in

Amanã, and nearby communities benefited from the services located in Santo Agostinho (elementary and middle school classes, a local health center, women's handicraft workshop, small commercial store, community space area, etc.), I suspect wages have a higher importance for the sample considered in this research.

In the study conducted by Peralta and Lima (2014), households at Amanã had the highest contribution of income coming from commercialization of agricultural goods relative to other areas in their study, representing the second most important source of income (18.6%) after social benefits, and wage contributions appeared in the third position (15.7%). Agricultural practices are important in the livelihoods and domestic economy of Amanã residents (as discussed in Chapter 1), exemplified by the commercialization of manioc flour by at least 60% of households in the communities studied here.

People from most households mentioned going to town at least once a month to make their purchases. These purchases included mostly food and were referred to as *rancho*. Frequently the rancho could also include cleaning supplies and gasoline in addition to food items. I actively interviewed people about what they purchased and did inventories of their food purchases and food "pantries." In the poorest households, purchased foods were kept in large plastic bags, many times in the room where the head of household couple slept. In houses that had cupboards in the kitchen, people kept food there. The following foods were present in almost all ranchos observed: rice, beans, coffee, sugar, vegetable oil, margarine, dairy powder, crackers, cookies, bread, juice powder, garlic, and onions (Chapter 2 delves into food consumption in greater detail).

There was some variation in the frequency that people went to town. Most commonly one or more household members would go to town every month, but there were also households in which people would go every other month or less, or more than once a month. In a few cases, an adult member attending university would stay in town for extended periods of time, such as a full month. It was less common for the whole family to travel, but it did occur in a few cases, especially when a close relative lived in town, with whom the family could stay.

One important reason for going to town was to visit the bank and withdraw the Bolsa Familia and the Bolsa Floresta benefit. If the money is accumulated for more than three months, then it becomes unavailable for the beneficiaries. Given that it was costly to travel, in terms of the gasoline, time, and accommodation in town, some people mentioned waiting for two or three months to withdraw the money. There was also significant variation in terms of who was responsible for traveling and bringing home the rancho. Many women mentioned it was a difficult task for them to do by themselves given that it required carrying the items to the boat, especially when they wanted to buy from onshore shops, instead of from businesses moored to buoys in the river or lake, referred to as "floating" markets (*flutuante*). When the couple went together, it was common for them to separate tasks. It was common for women to buy clothes and toiletries, shoes, or school materials (including materials for school events and parties), while men would secure the rancho and purchase fuel including groceries and gasoline.

HOUSEHOLD MONEY MANAGEMENT

The economic anthropology and sociology literature show that meanings are attached to money by the production of difference in its separation , either for a certain purpose, or based on its source or destination (Zelizer 1989; Wilk 1994; Kenney 2007; Carruthers 2010). The analysis below departs from three general categories for modes of household money management, based on how money is separated: obligated, personal and general fund. *Obligated funds* are set aside for a specific allocation, such as food; *personal funds* are exclusively controlled by a household member; and *general funds* are resources without prior constraints, to be used in the future (Wilk 1993).

For the sampled households, types of management were classified into three groups, based on polling of funds and decisions over money expenditure: joint, joint flex, and separate. These categories were defined considering women's description of management and expenditure in their household. In 12 households, money management was considered strictly joint, given that there were no personal funds, resources were all pooled, and the couple seemed to make purchasing decisions informed by one another every time. Joint flex had mostly the same features but there was a percentage of personal money, and that was the case for 11 households. In separate management, the division of funds was clear from the beginning, and household members had control over their own cash income usage. However, in all 11 cases of separate management, there were certain circumstances in which members would reach out to others when perceiving it necessary. Examples of these three cases are quoted below in respective order.

- Leide's quote about household money management, classified as **joint**:

> "We put the money together, the money he makes with the fish, with the money from selling crafts, we put everything together, and then we will see"

- Vanda's quote about household money management classified as **joint flex**:

"We put it all together (...) he does not hide any of his money, no (…). Last month I bought some rancho and some clothes for them (…) when he realizes, I have already bought things"

- Dores' quote about household money management classified as **separate**:

"Look, here in this house Pedro has his money and I have mine (…). I receive a pension and I work with craft making, and this money is sacred, he never asked for a penny. "

In addition, Dores mentioned some examples of negotiation when problems arise, such as when she paid for the university tuition of one of her sons, even though the agreement is that Pedro is the one responsible for paying it:

"This month of July he paid for it *[referring to monthly tuition paid by Pedro]*, but for March, April, and May I ended up paying, because his father was sick *[referring to her father in law]*, and so I said: no, let me pay for the studies of the boy. "

The BFP benefit management and use depend on the general mode of household money management, as described above. For the 12 households, which had joint management in general, half included the BFP benefit with other sources of money, while the expenditure was not differentiated. In six, however, the benefit was being treated as an obligatory fund. In those cases, it was possible to track expenditure based on interviews and informal conversations.

In the 11 households under the joint flex category, there were three households in which the BFP benefit was treated as a joint fund, and one in which it was strictly used for payments towards a rent-to-own (RTO) item (obligatory). In the other seven cases the BFP benefit was treated as personal money, controlled by women in four of them (one exception alternated between joint and personal depending on month necessities) and by men in the other three.

Lastly, in the 11 households where money management was separate, nine were women's personal (in one out of these, half the amount was obligatory), one was man's personal and one was mostly man's personal money, sometimes negotiated and partly spent by the woman.

In total, of the 34 households considered, nine did not systematically separate the BFP benefit from all other sources of income (Table 40). In more than 70% of these (25 households), the BFP benefit was separated either as an obligatory fund only (24%, 6/25), as a women's personal fund, including obligatory or obligatory parcel (52%, 13/25), and as men's personal fund also including obligatory parcels (24%, 6/25). The vast majority of the women identified the BFP benefit as separate money, and removed from all other sources of income. Women identified the purpose of the benefit, and in interviews outlined the meanings attached to it, particularly when explaining their reasoning for control or benefit use.

Table 43. Types of BFP benefit funds, and general money management

General household management	**BFP benefit not separated**	**BFP benefit separated**
Joint (12)	6	Obligatory fund (6)
Joint, flex (11)	3	Woman's personal fund (3), Woman's personal/obligatory fund (1), Man's personal fund (3), Man's personal/obligatory fund (1)
Separate (11)	0	Woman's personal fund (8), Woman's personal/obligatory fund (1), Man's personal fund (2)

WHAT ARE PEOPLE BUYING WITH THE BFP BENEFIT?

For the months in which I actively interviewed women about BFP usage, of the 34 households considered, in 15 (44%) the benefit was used with household rancho (Table 44). Purchase of RTO household items with BFP benefit were also common (26%, 9/34), but less frequent than expenditures on ranchos. The RTO mode of buying was used for the purchase of household appliances, electronics, furniture, and shoes and clothes (Figure 50). Given the small sample size and the large variation in items bought with the BFP benefit, comparison between different modes of management is limited.

Table 44. BFP management and items bought with BFP benefit

Items bought with BFP benefit	**BFP management**			
	JO [a]	PW	PM	Totals
Mentioned rancho only	6	0	0	6
Mentioned rancho and items for children	0	8[d]	1[f]	9
Only mentioned items for children	1[b]	5[e]	1[g]	7
Did not mention rancho or items specifically for children	3[c]	0	4[h]	7

JO: joint or joint flex, PM: personal man, including obligatory PW: personal woman, including obligatory, RTO: rent-to-own.
[a] 5 unknown, no clear rancho priority, [b] RTO semiautomatic washing machine; [c] RTO generator; RTO freezer, RTO TV; [d] household rancho when couple cannot afford it (or towels and hammocks); partial household rancho when husband cannot afford it (RTO mattress and shelf); household rancho and clothes for children (2); household rancho when couple cannot afford it (or RTO TV, clothes for children); half of household rancho (or clothes and shoes for child); partial household rancho when husband cannot afford it (or clothes and shoes for children); household rancho and clothes for children; [e] RTO shoes, clothes and bags/daughter's health exams and food while in town; shoes, clothes and school materials for children; older daughter stipend, food while in town and school materials; bicycles for her children; RTO laptop and cell phone, and school materials. [f] household rancho for consumption and sale, school materials; [g] RTO sound system; [h] house building materials and construction helpers; diesel for communal generator; unknown but negotiated with woman sometimes; unknown to woman who pays for rancho.

However, when the benefit is managed jointly, expenditure with rancho seems quite common (6/10), and a similar pattern is found when the BFP is managed personally by women (8/13), in the latter case, combined with items for children. Despite the small sample size, the data suggests BFP expenditure with food is less common when men have control over money usage (1/6). Of the 15 households in which the benefit was spent with rancho, in eight the benefit was women's personal fund, sometimes or partially obligatory for rancho or combined with clothes for children; in six it was a joint fund, two in which it was obligatory for rancho, and in one, as a man's personal fund, the benefit was used for household rancho, combined with food for sale and school materials.

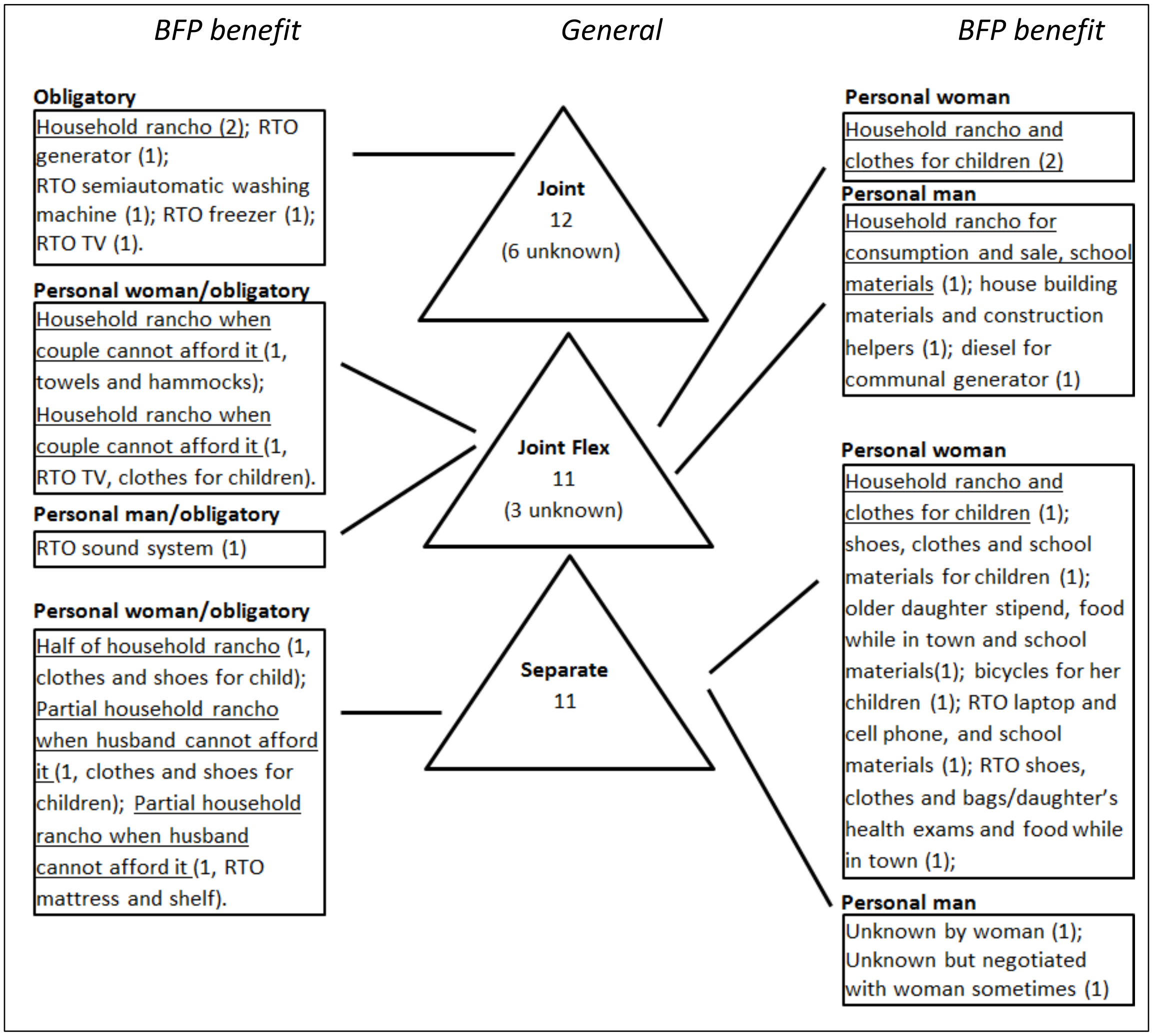


Figure 50. Items bought with BFP benefit and types of management

In the nine households where the BFP was not separated systematically, five were considered missing and not included in Table 44. The remaining four were included as rancho only, given that, monthly pulled resources were on a tight budget in every interview, barely enough for buying rancho, as illustrated in Cintia's account below. Cintia is in her early 30s. She works mostly in the manioc fields with her husband Eusébio. Eusébio also works during the pirarucu fishing season, and Sara, their older daughter who is 12, wrote a photovoice about preparing him some fried bananas for the trip to the lakes. Neither Cintia nor Eusébio have any wage jobs, and their income comes from productive activities managing natural resources and from social benefits (BFP, Bolsa Floresta, and seguro defeso). They have 5 children, and Sara usually stays in the household taking care of her siblings. Michael, Sara's youngest brother, is only a few months old. Here is an excerpt of one of my interviews with Cintia:

> "(…) we buy rancho first, right? Then we will check how much is left (…), and with that we buy clothes for one, or for another (...). This last trip I only took *tucupí* (sauce produced from manioc processing) and scrap metal that we sell there (...). There was nothing left on this trip, it was really not much"

In the five households with joint management where the BFP benefit was not separated (unknown expenditure), rancho was mentioned as important but members pooled resources and were able to spend on other items. For instance, other priorities such as 10% tithing for the church, rancho to feed assistant crop producers, and RTO appliances were mentioned.

FAMILY DEBIT CARD, MY DEBIT CARD, OR HIS DEBIT CARD?

Given that the law regulating the Bolsa Família[20] states that the benefit should be preferably transferred to women in the household, and previous literature refers to an overwhelming control of the benefit by women in the household (Rego and Pinzani 2014), it was expected that women's personal control over the management of the benefit would be a norm. While it was common, the BFP benefit was administered by the woman in 38% of the cases analyzed, joint management was more frequent (44%), and in 18% of the households, surprisingly men controlled the benefit (Table 44).

These differences were often described by women as a function of characteristics inherent to the program, such as referring to the debit card as the "family card" or, on the contrary, as "my card, " adding that the BFP debit card had to be in the name of the woman for her to decide how to spend it. The name printed on the front of the debit card was also an important factor associated with control over the benefit, but the reasons for a certain name to be printed were unclear. I discuss this further in this section, inserting accounts from an interview with the manager of the BFP at the municipality level.

Another common pattern for reasoning about control over the benefit management was the use of income from other household members as a reference. For instance, if the man or woman of the nuclear family did have a source of steady cash income and the other did not, then the reasoning was that the latter should be controlling the BFP benefit. Linked to that, women would refer to contributions of each household members with workloads to justify being entitled to use cash income from certain activities or not, such as making and

[20] Law number 10.836, January 9, 2004.

commercializing *farinha* or crafts. I outline some examples of all reasons mentioned above in the next paragraphs.

The reasoning behind the BFP being a joint fund is illustrated in Leide's accounts. In Leide's household the management of the money was strictly joint, and although her husband's name, Roberto, was the one printed on the BFP debit card, she did not express having any problems with that. When talking about the BFP and the Bolsa Floresta debit cards, Leide said:

> "It does not matter which debit card, one or the other, it does not matter that it is in his name, or in my name. Here everything is ours."

During another interview Leide also mentioned:

> "If the card is the Bolsa Família, then it is for the family [*referring to the word family as part of the name of the program*], then nothing is mine, or of any one person."

On the other hand, some women argued vehemently that they should have control over the BFP benefit, always referring to the debit card as their own card, and to the benefit as their own money. One woman, Neide, mentioned that she had had problems in the past when her husband took the debit card to town and spent all the money on alcohol. Indeed, Genésio had a problem with alcoholism. After a few cases, she decided to take control over the use of the card, even though Genésio was the one with the name printed on the card.

Neide always referred to the BFP debit card as her card:

> "*I* am the one who withdraws and spends the money. It's always in *my* purse."

Selena has her name printed on the card and controls the management of the money. During her interview she mentioned multiple times that she "drives her money":

"I am the one who drives it [*referring to control over the BFP benefit*], he [*referring to her husband*] does not insist. He has his money and he decides on that."

When Teo, her husband, goes to town, she sends a detailed list of what she wants him to buy with the BFP benefit. She said he does it "exactly the way she wants," except for when he forgets a few items (she mentioned bleach from rancho the last time) or buys something slightly different from what she likes. The last time he had been to town before I talked to Selena, Teo bought soap with coconut scent, even though Selena told him many times that coconut scent does not smell like anything, and she wanted one with a stronger scent. Selena is in her 50s and her youngest son, Alfredo, is the one on her BFP card. She mentioned spending the BFP on specific kinds of pants and shoes that he liked, which, according to her, were not cheap. Selena mentioned that Alfredo is very demanding about which brands he likes, and one of the shoes she bought for him took up more than half of the BFP monthly benefit one time.

In the six households where the benefit was considered a man's personal money, the card had their names printed on it. Of the 34 households, in nine (26%) the card was printed in the name of the adult male member of the household. In five of these cases the adult woman had a steady income, higher than the man's (when the man had any), either working as a teacher or receiving disability pensions. In one other case, Leide, mentioned above, did not receive a salary, but produced the most handicrafts in the community, with help of her daughters and occasionally of her husband, Bené. In the remaining three households, the use of the BFP benefit is somewhat contested. The three women expressed dissatisfaction, and had little or no control over how the benefit was spent (two women), or argued for having total control, Neide, as shown in her account below:

> "(…) because every time he would get the money to go buy our rancho in Tefé, he did not buy it. (…) it is not yours, it is mine, it is ours, I say. Then that is it, he doesn't say anything (…) I tell him right away that it is our kids' money (…)"

Having the name on the card was important, but not always enough. Two women who did have their names printed on the card did mention some dissatisfaction over the control of the benefit. Mara, for instance, told me that her husband Armando is always the one who decides how to spend the benefit. Mara was the only woman who asked me for not to record any of our conversations, and told me she did not agree with her husband buying a RTO sound system with the BFP benefit, even though her three older children were the ones who asked for it.

Moreover, although Amanda described the management of the benefit as "joint flex" during formal interviews, she revealed some problems with control over the benefit in informal talks. In her interview she mentioned that sometimes she is the one who decides how to use the BFP benefit and sometimes they decide to pool funds in the household. She said:

> "He already has his [*money*], right? And sometimes I want to buy something, and so I also have mine [*BFP benefit*], I don't want to ask [*for money*] from him" (…) "This last time we put it all together (…), bought things for the party [*that month was going to be the traditional party that the community organizes every year*] (…), ice to bring chicken and sausage (…)"

Amanda has two young sons and stays mostly at home, and her husband Manoel works as a teacher and receives a disability pension. In an informal talk, Amanda mentioned to me and to other women in the community that one time Manoel did go to town, took *her* BFP debit card, and spent all of his money and the BFP benefit there, coming back without any money for the month. Cases such as this one mentioned by Amanda seemed rare in the households studied.

The quote above, from Amanda's interview, shows how control over the BFP benefit is justified in terms of a reference to the income of another household member. In most households where the BFP benefit card had the name of the man printed on it, women seemed to be in favor of men controlling the usage of the benefit. In these cases, women justified it by showing their husbands did not have a source of steady income, as they themselves did, either from another social benefit (retirement or disability salaries) or school wages as teachers. For instance, Veronica is a teacher at the local school and she described the BFP benefit as a joint fund. She said:

> "There are things we buy RTO because we don't have money to buy a lot, right? (…). Our income comes from what I make and from what he makes too (…). Mine is from my profession of being a teacher, I earn my salary, right? And his is from the Bolsa Família that is under his name, and from extra work he does."

Veronica thinks it is "not a problem at all" for the Bolsa Familia to be managed by her husband Carlos. She said:

"For example, I feel like getting something, I go and buy it, and when I arrive I just show him and he does not say anything, so there is no problem for the card to be on his name [*referring to the BFP debit card*], for me it is normal"

In this sense, there seems to be an association between household income in general and modes of BFP management specifically. To test if the BFP mode of management differed significantly across income, I conducted an ANOVA with income as a continuous variable. Levene's level test results show that the homogeneity of variance assumption is tenable $F(2, 31) = 0.02$, $p = 0.98$, and there is no significant deviation from normality within these groups using the Shapiro-Wilk normality test: joint management ($W=0.88$, $p=0.06$), personal woman management ($W=0.9$, $p=0.15$), and personal man management ($W=0.93$, $p=0.61$). BFP benefit mode of management did not statistically differ by income level $F(2, 34) = 2.25$, $p = 0.12$ (Figure 51), but the small and unequal samples may have compromised the detection of differences (small post hoc statistical power, equal to 0.11, for comparison between joint management and others). When income is categorized in 3 levels, a significant difference is detected, $\chi2(4, N = 34) = 9.85$, $p = 0.04$ (statistical power is significantly improved, equals to 0.39), showing an association between lower income per capita and joint management of the BFP-benefit in the household, and higher income per capita associated with women's control over the BFP management in the household (Table 45, Figure 52). Looking at the same relationship, using Fisher's exact test, a method for computing probabilities when sample sizes are small, there is also a significant difference between groups ($p = 0.02$).

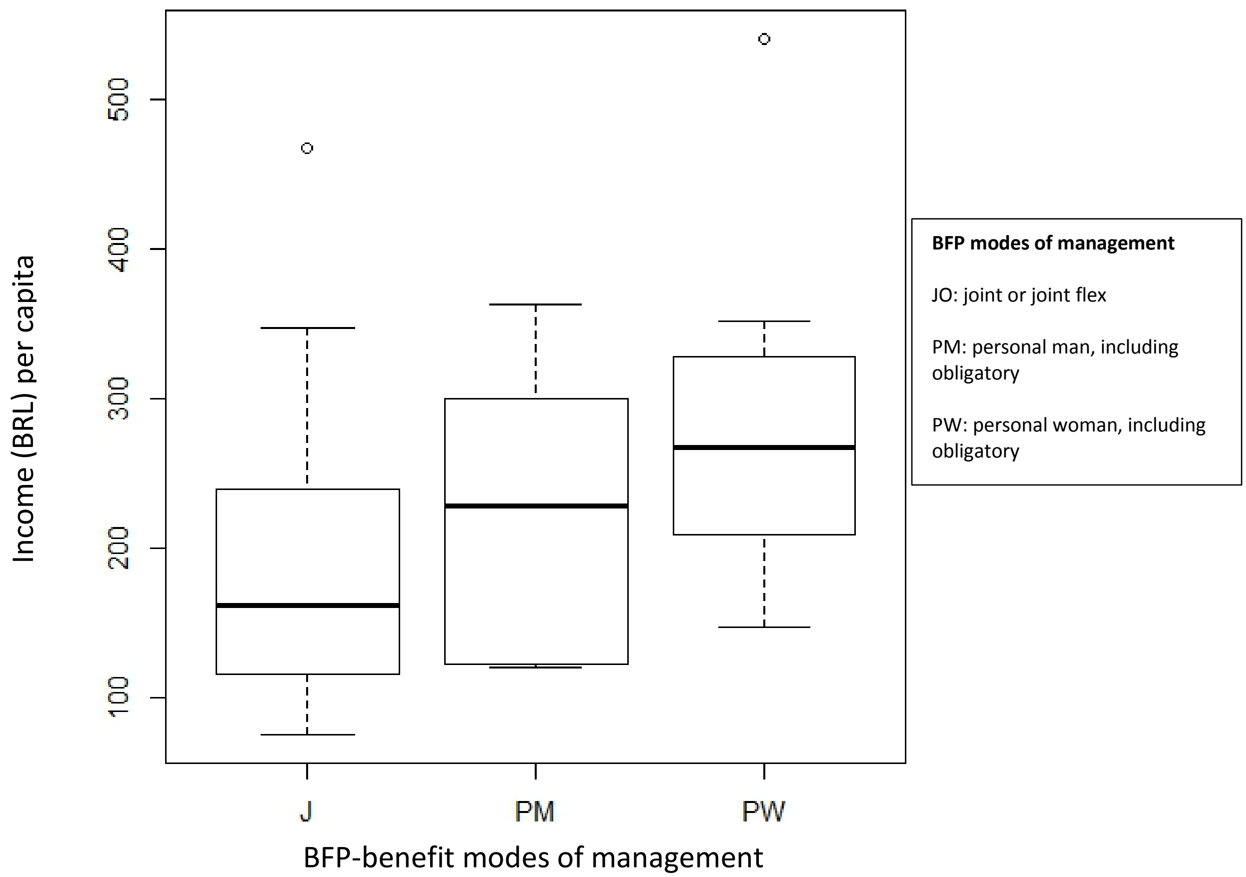


Figure 51. BFP management by household income per capita

Table 45. BFP management and income level categories

Income/month/capita	**BFP management**			
	JO	*PW*	*PM*	*Totals*
Less than 140 BRL	6	0	2	8
Less than 250 BRL	7	5	2	14
Less than 550 BRL	2	8	2	12
Total	***15***	***13***	***6***	

JO: joint or joint flex, PM: personal man, including obligatory PW: personal woman, including obligatory. $\chi 2(4, N = 34) = 9.85$, $p = 0.04$ (Fisher's exact test $p = 0.02$)

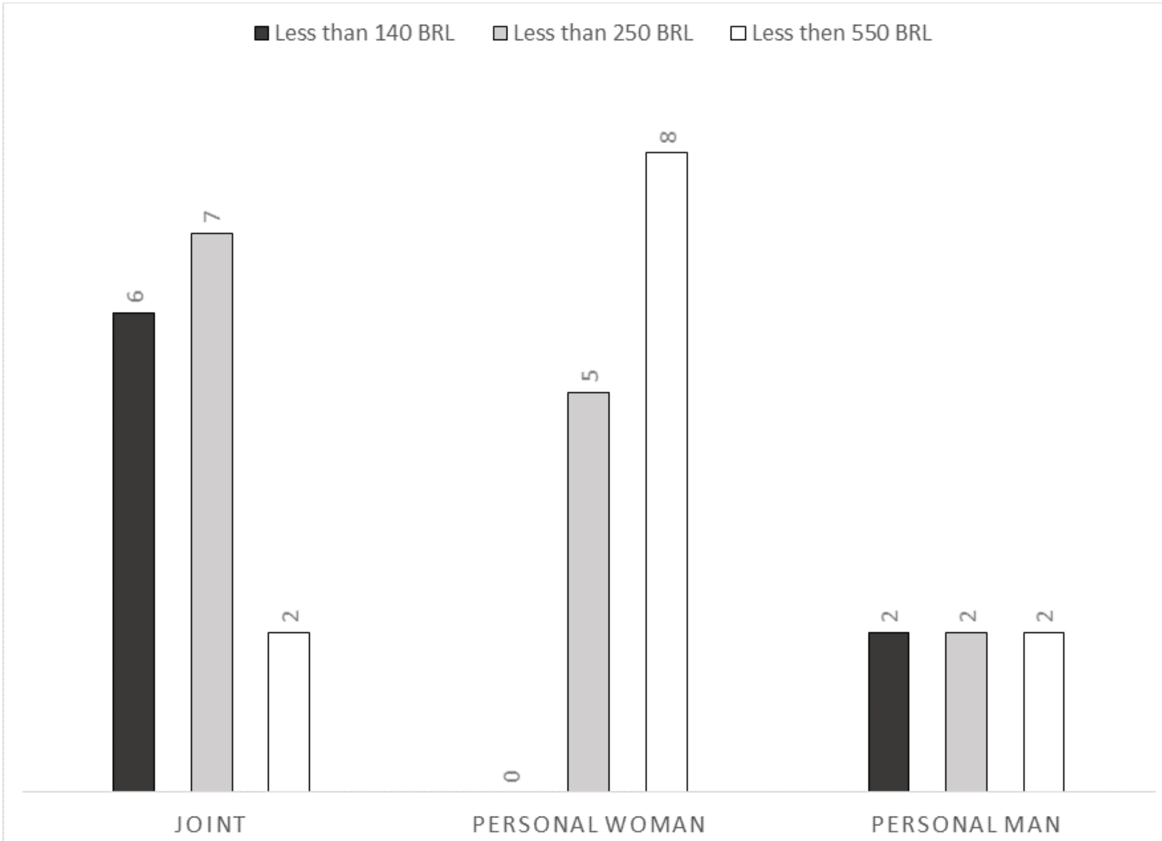


Figure 52. BFP-benefit modes of management by income level categories

As suggested earlier, when the BFP benefit expenditure is controlled by women, it is not only linked to rancho, but also to purchase of items for children (Table 44). Some women (26%, 9/34) expressed that rancho was a man's responsibility. So, either the couple or the woman would make a monthly rancho list, but the male was the provider for purchases of those items. This view was clearly brought up in my interview with Jasmine, a 48-year-old woman, who lived with her husband, 5 of her children, a grandson, and a granddaughter. She explained:

> "(…) every month I need to buy rancho. I am, I am the man of the house, right? Sometimes I get upset with him because he is the one who should buy it, but I am the one buying."

In most cases, however, rancho was viewed as a couple's responsibility. In households with separate money management the coupling of money contribution for it was evident, and some women were straightforward about it. Dora, a 57-year-old woman, who lived with her husband, Benedito, and 2 of her sons, José, who was 27 years old and a Jonathan, who was 12 years old. Dora told me:

> "I have my Bolsa Família and he [*referring to her husband*] has his salary, right? Then I give 100 and he gives 100. Two hundred reais is our rancho, and that is how we do it. Every time it is like that."

Dora mentioned that none of her other children would spend more than a month living with them at Amanã, but her other 3 daughters and 2 sons often visited, and I encountered them at her house many times.

THIS MONEY IS NOT FOR THE PARENTS, IT'S FOR THE KIDS

In addition to the previous section, control over the benefit was tied to women's perceptions of what types of purchases should be done with the benefit, the most apparent linked to children's school and food necessities, sometimes with clear divisions for each child. This was the case not only for women who had total control over the expenditure of the benefit. Although the data suggests that when women do have control over BFP expenditure, the partitioning of funds directed at each child actually took effect, and women would indeed spend the money with items for children.

A dissonance between expenditure and reasoning about how the money should be used, especially when the benefit was managed jointly, is illustrated in the case of Iara's household, in the account below. The first time I interviewed Iara, she felt very strongly about how the benefit should be used. It had to be used for purchasing items for children, and similar ideas were expressed by many women:

> "The Bolsa Família benefit is not given to the father or the mother, it is for the kids in your house (…). If I want a TV, I go there and make a payment for it [*referring to RTO*], I can't do that (…) because this money is to buy school materials for your kids, or for example, food for kids to take to school when they don't have anything to eat there."

In a later interview, Iara mentioned her and André, her husband, decided to buy an RTO freezer and were saving the BFP benefit to pay for it, without making any judgement about it. This dissonance may be a function of misunderstanding or fear about losing the benefit. Mixed messages about the program come from many sources, including the media, local health agents who collect anthropometric data on mothers and children, staff at the governmental bank where they withdraw the money, and from the staff at CRAS, the municipality branch responsible for managing BFP program at the local level.

Rosa's account is interesting because she justifies usage of the BFP in terms of how it would assist her children:

> "I thought hard. What do I do? I have to buy a machine to assist with washing these kids' clothes. I don't think this is a mistake. This is something that will help them. I have been washing clothes by hand for 52 years. And that's what I thought. I thought: you know what? I am going to get an RTO washing machine to wash these kids' clothes. And that's what I did. And I am paying for it."

Rosa’s household was one of the poorest in the communities. Rosa locked the food she bought in a large wooden box and kept the keys with her when she left the house. Sometimes her grandsons and granddaughters would come visit and there would be around 15 children present. She had a 15-year-old son and a daughter with disabilities, likely associated with pregnancy at an advanced age. The washing machine Rosa was referring to in the quote above is one that does not have a centrifuge. The generators in the communities are not potent enough to power a washing machine with a centrifuge. Moreover, the latter is more expensive, especially in such an isolated place. Rosa still had to drain the clothes by hand before hanging them outside to dry. The passage above also demonstrates some pride on her part in the fact that Rosa contemplated, made a decision about this purchase, and is now able to follow through by paying in installments.

It is evident from the data that when the BFP benefit is a personal woman’s fund there is a tendency of to funnel it toward purchases of items directed to individual children, including RTO items and food. For all 13 women who managed the BFP benefit as personal money, all mentioned buying items for children, and only one did not specify a particular child. For instance, Helena paid for the installments of a laptop twice with the benefit from the BFP specifically because her older daughter, Catá, insisted for months after taking a short-term computer science course in the nearest town. Helena often expressed her worries about Catá who had serious psychological health issues. From Helena’s accounts, it seemed like her and Walnei, her husband, were attempting every possibility in order to make their daughter feel better. She mentioned taking her to the doctor in town and to different churches. Helena is very religious, but when Catá decided to attend a church different from the one Helena frequented, Helena supported and encouraged Catá, with hopes she would get better. This context may be related to Helena purchasing objects Catá wanted in order to help her. The account from Helena below illustrated the household decisions and expenditure with the Bolsa Família:

> "If she says something [*referring to Catá*], Walnei will make an effort and do everything he can to buy it. She wanted a laptop because she did the computer science course. I want a laptop so much [Helena *pretending she was Catá*] (…). Then he bought it RTO and we are paying now. I paid for the installments twice with the Bolsa Família (…)"

Later, in an informal conversation, Helena told me that Catá decided to sell a cell phone that Walnei was still paying for in installments, without consulting her parents. Catá sold for cheaper than it was bought and Helena expressed her frustration, but also told me she decided not to buy any electronics for Catá anymore. Helena's story is an example of how parents go through struggles in order to please younger generations living in these rural communities with periodic access to urban life. This younger generation constantly express their aspirations and may feel entitled to the Bolsa Familia expenditure. Making household expenditure decisions and agreeing on the most appropriate way of spending the BFP benefit becomes a great challenge to mothers, and the purchase of RTO items represents long-term commitment to the household budget.

Indeed, the results of coding interviews on qualifications about the BFP also revealed a theme of purchasing items for children (19 out of 34 women). Dora was very straightforward about that in her interview, especially in terms of her having the authority to make a decision about the expenditure of the benefit: "(…) I buy because I want to buy for him [*referring to her* *youngest son Jonathan*]. He is on my card, you know? Then I have the right to give him something." Also, Joelma mentioned her husband, Mariano, and she decided to buy the glasses her youngest daughter Nicole needed with the BFP benefit. Nicole chose a frame that was more expensive than their parents could afford with the BFP benefit, but they decided to give her the one she wanted. Joelma told me her two sons were angry with Nicole and told her that in the coming months their parents would not purchase anything for her.

In terms of men's control over the expenditure of the BFP benefit, there were few variable cases. Expenditures, however, were more variable, ranging from purchases of gasoline for transportation and house construction, to children's material desires. The latter exposed in Mara's account:

> "They asked [for a sound system] from their dad and he said he'd buy [it] with the Bolsa Família money, but that he would not buy their school materials. So, they had to take good care of their materials, since they wanted [a] sound system."

DISCUSSION

As described previously in the introduction, household money management is highly variable, and depends on many contextual variables (e.g. (Kenney 2006; Chibnik 2011). Variability in household decisions in Amanã was apparent, both in terms of the pooling or separation of money, and in control over money management (Table 43). On the other hand, the BFP benefit was clearly separated (more than 70% of sampled households). This pattern of separation either for a specific purpose or for personal control suggests that the benefit does change the structure of household money management, as proposed by (Haddad and Kanbur 1990) when analyzing the consequences of conditional cash transfers (CCTs) at the household level. When household money management was joint, the BFP benefit was 40% of the times separated to buy rancho (monthly groceries purchased by residents in town, as outlined in the "Household profiles" section) and in households with separate money management, the BFP benefit was most commonly managed by the woman and always spent on food and/or various items for children (Table 44). Women felt strongly about how the BFP benefit should be used, especially linked to children's necessities, and expressed dissatisfaction when the benefit was not used in agreement with them. Moreover, the data suggests that when women secure other steady income for themselves, their participation in decisions around the benefit expenditure becomes less important for them. The relationship between income and BFP benefit management is evident, with women managing the BFP benefit in households with higher per capita income (Table 45).

The results on household money management from women's interviews show high variability in the process of negotiation. The data shown here represents a snapshot of the perspectives that women voiced about internal household negotiation. Despite the variability encountered, general patterns did emerge, similar to results reported in the literature published on household money allocation. Essentially the issue of pooling or separating resources was present in all households, ranging from the extremes of strictly pooled to strictly separated funds. The results show no prevailing pattern of money management when considering the terms outlined above. There was a similar number of households with strictly pooled funds, strictly separated funds, or who were very flexible on this spectrum (Table 43).

On the other hand, in more than 70% of households the BFP benefit was separated either as a fund specific for the purchase of a certain item (obligatory fund), or as a fund managed by a specific member of the household. From an anthropological perspective, this benefit separation pattern shows that "not all cash is alike" (Lemon 1998), and the practices attached to expenditure of the BFP benefit demonstrate that this differential allocation in budgets denote special meanings, creating distinction on the basis of the source or destination (e.g. as argued in Carruthers 2010; Zelizer 1989).

Surprisingly, joint management of the BFP benefit was more common than personal women's management in the sampled households in Amanã. The results show that the name printed on one's card and household per capita income may be playing an important role in how money is managed. When the man's name is printed in the card, it is more likely for them to have control over the expenditure of the benefit. Again, the name printed in the card seems to have an importance in qualifying the money's source. However, as explored in Neide's account in the "Family debit card, my debit card, or his debit card?" section, a woman may strongly impute other meanings to the BFP benefit; negotiate in order to "overthrow" other rationales in household decisions; and assert personal control over management, even when her name is not printed in the Bolsa Família debit card.

When the management of the benefit was joint, women knew how the money was spent and they participated in decision-making. Women alienated from household decisions related to the BFP management seemed uncommon, although as mentioned, I was unable to interview a few women (missing data), even though I lived nearby and in the communities for extended periods of time. Still, this number was low and my understanding is that most times their reasons were related more to logistics than with our lack of rapport over sensitive issues. There were cases of women who reported dissatisfaction because they did not participate in decisions concerning BFP benefit use, as conveyed in informal conversations and interviews in which certain women requested I not record them (i.e., accounts by Mara and Amanda discussed in the “Family debit card, my debit card, or his debit card?” section).

Results show that Involvement of women in the management of the BFP benefit is the norm, which is likely linked to meanings attached to the BFP program. Women probably perceive this in their interactions with radio or television news media, as well as with local authorities. Even though there were no cases of women mentioning they disliked the program or thought it was unhelpful, they did cite struggles and challenges in internal household negotiations. These are illustrated in the accounts from Iara, Rosa, Dora, and Helena in, for instance, the “This money is not for the parents, it’s for the kids” section.

In terms of expenditure, when the BFP benefit was managed as a joint fund by the nuclear family couple or by the woman, the purchase of food was always mentioned: either all of it would be spent on food (more common in joint management) or with food and other items for children. The most common justification for BFP benefit expenditure expressed by women in interviews was the purchase of items for a specific child, or how certain items would benefit children in the household. Moreover, in some accounts children’s agency in making decisions was clear (e.g. in the case of Nicole and her siblings as well as Mara’s sons, both accounts presented in the “This money is not for the parents, it’s for the kids” section). The items purchased for a specific child or rationalized as being for children varied widely, as summarized in Figure 50.

It is important to note that all households studied in this chapter are composed of a nuclear family, as described in the “Household profiles” section, often complemented by visiting and permanent extended family members. For the households studied, the results explained above show patterns of management and expenditure that seem to translate to how women in the nuclear family perceive and act based on meanings attached to the BFP program. For instance, the separation of the BFP benefit and women's input on how it should be managed show they feel responsible for making sure that the benefit is used for a certain purpose. This purpose seems to be significantly attached to purchases that furnish items for their children.

This sense of responsibility for management of the money appears diminished when the woman secured a steady source of income from her work, although evidence for this pattern is anecdotal and stems from a limited sample size. The literature does show a strong association between women's contributions to total income and women's control over resource allocation in households (Kenney 2006; Schmeer et al. 2015). Moreover, there was a clear association between household income level per capita and mode of BFP benefit management. When income per capita in the household is higher, woman's control over the BFP benefit management is more common, and consequently items seem to be bought with specific children in mind.

Meanings attached to the source of the income suggest that the BFP does change the structure of money allocations and control. Additionally, the fact that in households of higher income per capita the BFP benefit is more likely to be managed by the woman instead of jointly, suggests that an income reference also plays a role in control over the BFP benefit expenditure. Assuming that poor households are facing a risky scenario of shortage in attaining basic needs for members, this evidence from income fits prospect theory, with expected income from all members as a reference.

As outlined in the introduction, prospect theory is a model for decision making in risky scenarios. One of its main principles is that in such a scenario, decisions are made based on a certain reference point (Barberis 2013). This reference has been defined not only in terms of experience and memory, but more importantly by expectations (Kőszegi and Rabin 2009). Therefore, in the poorest households, the BFP benefit is virtually the only expected income and possibly the single most reliable reference for making money management decisions. On the other hand, in households with higher income per capita, the reference may be composed by other sources of steady income.

Assuming the model above, one possible explanation for personal money management and expenditure with items for children in households with higher per capita income is that with a higher availability of funds, the BFP benefit can be used as women perceive it should. The results show that women do perceive the benefit as a fund that should be managed either by them or with their input, given that women justified why this was not the case and showed dissatisfaction otherwise. Moreover, when having control over expenditure, women seem to have closely followed the discourse of the benefit's purpose as being directed at children. They mention purchasing items for a specific child in the household. In sum, when the reference income provides some "surplus" it is more likely that women will control the expenditure of the benefit and spend the money on children's aspirations, including expensive items that they can afford by buying rent-to-own, given the stability provided by the BFP monthly cash transfers.

The appointments above also match the idea that CCTs allow for planning budgets. Steadier incomes not only in the form of the BFP would provide households with more leverage for planning and pondering (Banerjee and Duflo 2012), as well as having money after meeting basic needs. Thus, in some instances people are able to spend the money on other priorities which make sense to them. In terms of food, it may be adding variety to diets, especially with rare items which cannot be produced, or purchasing foods valued by children. This hypothesis can be tested by singling out specific food items of their purchased rancho. In terms of other items purchased, the possibilities are as variable as household members' aspirations.

It seems appropriate now to return to Maria's story presented in the introduction of this chapter. When Maria still lived with her parents, she decided to give Mario, her father, the BFP benefit that she received every month for more than a year. According to her, with this money Mario was able to build a bathroom with an elevated water tank, a toilet seat, a sink, and a shower head indoors, a rarity in these communities. Maria had great admiration for her father and told me this story with much pride, as she was able to help him realize his dream. When I stayed in Maria's old house, however, I never observed the shower head being used. Vania, Maria's mother, chose only to bathe in the river, despite the insistence of her children to not do so. The bathroom was used frequently by adolescents and children related to Vania (as well as unrelated relatives when they had a chance), including by her granddaughter Joseane, who has a photovoice about building a bathroom inside her own house, presented in the Appendix.

CONCLUSIONS

What are people buying and *how* are they making decisions about the Bolsa Família Program (BFP) benefit?

Here I show how these answers are highly dependent upon context, as well as how instrumental it is to look at household dynamics and negotiation in order to understand how the BFP changes the structure of money allocation and expenditure. These answers bare importance given the scale of poverty alleviation programs such as the BFP. The BFP is the most important public policy addressing poverty in Brazil, reaching a quarter of the country's population, and is acknowledged as an example of success to be implemented in other poor countries throughout the world.

With regards to how people were making money management decisions, it was clear that the BFP benefit is considered a "special money" that has a particular purpose, sometimes rationalized as money to help the family or children in the household, or money which should be controlled by women. These meanings are tied to the discourses attached to the program and to how the BFP is framed and implemented. In the households of Amanã, joint management of the benefit was more common than personal women's management, which was in turn more common than man's personal management. Women felt entitled to participate in decision making regarding the expenditure of the BFP benefit, whenever it was managed as a joint or personal fund. In the fewer cases in which women did not participate in decisions, either they did not see it as a problem, stating that they trusted men were making a good judgement or had mostly secured income from their own work outside the household. There were rare instances in which women were dissatisfied with men controlling the expenditure of the money.

Despite focusing on communities located in the Amanã Sustainable Development Reserve, this research shows how heterogeneous the group of households studied were, including in terms of income level. One example was the variability in how much the BFP benefit represented of the total household income (calculated as a sum of steady incomes), ranging from 89.4% to 6.6%. These results show that in some households in these communities, the only significant reliable source of monthly income was the BFP benefit, whereas in others it represented a reduced complement to other incomes from formal work.

These differences in income level among households are reflected in how the BFP benefit is managed in the household. In poorer households the money is mostly managed as a joint fund and women mentioned using it mostly on their monthly purchases of food and other necessary supplies (e.g. gasoline and motor oil for transportation), in wealthier households the money is mostly managed by the woman and is again used for food and other supplies, but it is commonly directed at the needs and wants of children in the household. Independent of how they spent the money, the majority of the women regarded the BFP benefit to be used with items that would benefit their children.

The results of this study show that negotiation *is* happening in these poor households, and, for the most part, women do not perceive household money expenditure as dysfunctional. Given available research on households in extreme poverty, this pattern does suggest that the BFP may be giving women more authority in household money management decisions. For instance, even with a small sample size of households in which men controlled expenditures, women, in general, knew what men were spending the benefit on and seemed to approve (e.g., when women mentioned men's expenditure of the benefit on building materials for household improvement or food and gas supplies).

In the case of the BFP program, children seem to possess agency in how the benefit is used. This fact was identified and even condemned in some households, but it does reflect a generational challenge that couples and particularly women, face when deciding on how to spend their BFP benefit. These households are located in a complex web of needs and desires expressed by their children, and are faced with a need to prioritize based on context and possibilities. These possibilities are expanded with the BFP benefit as a steady source of income, and with the aspirations of rural household members in recurrent contact with nearby towns. Conspicuous consumption or not, members of these households regularly purchase cell phones, laptops, sound systems, fancy clothing, as well as prepared food available for purchase when they visit urban areas. Enjoying an ice cream or a cold soda on trips to town is probably also part of this picture, as they are rare and highly prized treats, especially by children living in these communities. Notably, these foods are also becoming more available in rural communities.

CHAPTER 4: THE BOLSA FAMÍLIA IN LIGHT OF THE NUTRITION TRANSITION

RESEARCH PROBLEM: THE BOLSA FAMÍLIA PROGRAM (BFP) AND THE NUTRITION TRANSITION

Anthropologists have looked at diets and diet change from a number of different perspectives. Here I start by outlining the specific questions related to the main research problem addressed in this chapter, which is the effect of the Bolsa Família Program (BFP) on the diets of women in the rural Middle Solimões region. In particular, I investigate the extent to which women in the BFP program are consuming industrially processed foods more frequently than women who do not participate in the program. The premise is that industrially processed foods are at the core of what is considered a low quality diet (Monteiro et al. 2010).

The replacement of locally sourced foods by purchased items, to a large extent industrially processed, have been documented extensively in various areas of the developing world, following economic change linked to availability of cash, particularly linked to cash crops (von Braun, Kennedy, and Bouis 1990; Ulijaszek 1993; Finnis 2009; Wood et al. 2013; Reardon et al. 2014). However, as outlined in previous chapters, the mechanism and effects of economic changes on diets and health of particular populations require examination in different contexts, as is the case in the rural Brazilian Amazon.

To understand differences in diets of BFP participating and non-participating women, I address three research questions. The questions and list of hypotheses associated with each of them are explained below.

Research question 1 is: *are women living in households participating in the BFP consuming processed foods more frequently than women living in households not participating in the program?*

The first research question can be broken down in three hypotheses, looking at the level of industrial processing in items that are more or less frequent, comparing the diets of BFP participating women and non-participants. The three hypotheses are:

Hypothesis 1.1: Women living in households participating in the BFP consume unprocessed or locally processed foods (group 0) less frequently than women living in households which are not part of the program;

Hypothesis 1.2: Women living in households participating in the BFP consume food industry ingredients and ultra-processed foods (groups 2 and 3) more frequently than women living in households which are not part of the program;

Hypothesis 1.3: Women living in households participating in the BFP consume ultra-processed foods (group 3) more frequently than women living in households which are not part of the program;

The level of food processing was operationalized by adapting the classification proposed by Monteiro et al. (2010). I explain the classification and modifications in detail on the Methods and Analysis section. Foods were classified in four levels of processing, from the least to the highest industrially processed foods, ranging from unprocessed or locally processed foods (group 0) to ultra-processed foods (group 3). Industrial processing is defined as “all methods and techniques used by the food, drink and associated industries to turn whole fresh foods into food products” (Monteiro et al. 2010: 6). The difference from Monteiro et al. (2010) and this study is the focus and scale, here I conduct a comprehensive analysis of Amanã resident's diets, and Monteiro et al. (2010) work with Brazilian countrywide data and general trends, using governmental survey data collected mostly in urban areas.

The detailing of the level of processing for each hypothesis is instrumental in recognizing the nuances in the incorporation of foods to diets. For instance, differences in frequency of consumption of vegetable oil in the form of fried fish or fried sausage. The overall assumption is that women participating in the program will be consuming more industrialized foods and changing the structure of their diets, by substituting food items, following the predictions of a nutrition transition model. This model postulates a shift in the structure of diets, happening at a particularly fast pace in the last three decades in the developing world. This shift is commonly characterized by an increase in the proportion of energy in diets derived from fat (mostly vegetable oil), and caloric sweeteners (mostly sugar), which are frequently components of highly processed foods, as well as "ready-to-eat" foods. This dietary shift is accompanied by reduced energy expenditure, culminating in increased body weight associated with chronic diseases (e.g. Popkin 1993b; Caballero and Popkin 2002; Popkin and Gordon-Larsen 2004; Monteiro et al. 2013).

Specifically in the case of the Brazilian Amazon, among BFP participants, there would be an increase in the consumption of industrially processed foods, especially industrially processed meat such as sausages and canned meats (included in group 3), but also refined sugars (included in group 2) and purchased animal protein such as frozen chicken (included in group 1), as documented in other areas (Piperata, Ivanova, et al. 2011; Murrieta et al. 2008).

Given the above, research question 2 is: *Are women living in households participating in the BFP consuming purchased foods more frequently and local stables and snacks less frequently than women living in households not participating in the program?*

The second research question is broken down in two hypotheses specifying food items:

Hypothesis 2.1: Women living in households participating in the BFP will more frequently consume purchased rice, crackers, breads, chicken, and beef, than women living in households which are not part of the program;

Hypothesis 2.2: Women living in households participating in the BFP will less frequently consume locally sourced foods such as farinha, manioc products, fruit, fish and game, than women living in households which are not part of the program.

A third research question examines a generational component in the incorporation on industrially processed foods in diets. The premise behind it is that the nutrition transition from childhood to adolescence is associated with a shift to lower intake of fruits and vegetables, increased consumption of sweetened beverages, and energy-dense snacks (Lytle et al. 2000; Story, Neumark-Sztainer, and French 2002; Pearson, Ball, and Crawford 2011). The aforementioned studies stress the important role of the environment in changing dietary patterns. Therefore, rural residents, including children in the Amazon, may not follow that premise, as they are often described as active participants in food harvesting from production lots, gardens, and forest areas (e.g. Smith, Vásquez, and Wust 2007).

Research question 3 is: *are young women consuming processed foods more frequently than older women?*

The third research question is again broken down in three hypotheses, in the same fashion as the first research question, based on the level of industrial processing of foods consumed by women:

Hypothesis 3.1: Younger women consume unprocessed or locally processed foods (group 0) less frequently than women living in households which are not part of the program (controlling for BFP participation);

Hypothesis 3.2: Younger women consume food industry ingredients and ultra-processed foods (groups 2 and 3) more frequently than women living in households which are not part of the program (controlling for BFP participation);

Hypothesis 3.3: Younger women consume ultra-processed foods (group 3) more frequently than women living in households which are not part of the program (controlling for BFP participation);

In the following section I outline some of the main anthropological perspectives for the study of diets and diet change, setting a background for the line of thought and for my own conceptualization of this research. Food consumption is considered in light of general rules of cuisine, such as core energy and protein source foods (Dufour et al. 2016; Murrieta, Dufour, and Siqueira 1999), daily meal importance (Fajans 2013), foods recognized as validators, without which people do not feel satiated (Siqueira 1997), and secondary items often seen as mere compliments or “non-foods” (Murrieta 2001; Adams 2002). The strategy is to combine the most fitting theories with evidence on the ground, not only focusing on nutrition, but also on food categories, preparations, the meanings of foods and discourses surrounding them.

BACKGROUND: DIET AS A LIMITING FACTOR AND HUMAN ADAPTATION

There are thorough reviews published examining anthropological approaches of the 60’s, 70’s and 80’s on Amazonian human ecology, and the development of complex societies in the South American lowlands (e.g. Roosevelt 1980; Brondízio 2008; Murrieta et al. 2008; Balée 2013; Adams and Piperata 2014). In these works, authors expose the initial emphasis on ecological determinism and debates on environment considered as limiting factors for the occupation of the Amazon basin (e.g. Meggers 1954; Lathrap 1965; Carneiro 1970; Gross 1975; Moran 1993).These early works on the human ecology of the Amazon mostly engaged with cultural ecology, where culture adapts as a response to environmental limitations (Steward 1955).

In his theory of cultural ecology, (Steward 1955) argues that the environment has a central role in the process of culture change, stressing the idea of adaptation to environmental conditions, which affect a culture core, defined as essential features of social organization in people’s livelihoods and economic arrangements. Culture is seen as interdependent with the environment. Originating from this metatheory, one of the most heated debates on issues of adaptation to the environment in the 70’s revolved around the argument of low kilocalorie and protein availability limiting size and permanence of settlements in the Amazon (Carneiro 1970; Gross 1975).

Gross (1975) attempted to quantify food consumption in terms of protein needs for a certain population size in a defined area, comparing and reviewing data for different indigenous groups, and setting the stage for future mixed methods research in Amazonian studies. Beckerman (1979) conducted similar research, however refuting Gross’s arguments, using accounts of diet patterns and subsistence activities of a number of indigenous groups, as well as methods for calculating food resources (e.g. using aerial photographs). He argued that protein was not a limiting factor in the Amazon, but was in fact abundant from fisheries and other sources such as reptiles, beans, and nuts (Beckerman 1979).

Evolutionary ecological models are also based on the notion of human behavior adaptation to certain environmental conditions. In the Amazon, the optimal diet breadth model addressed the assumption that the range and proportion of food items in diets would be a function of maximizing energy intake (Hames and Vickers 1982). This model has been used to investigate the composition of game animals in diets as an adaptation to the variation in prey availability and short-term hunting strategies (Hames and Vickers 1982).

Independent of the limitations of these early works they have contributed to create a commitment among Amazonian anthropologists to study processes comparatively, to produce in-depth evidence through ethnography in combination with mixed methods (quantitative and qualitative), and finally to understand the extent to which the environment is part of and yet also influences human behavior. Moreover, the testing of evolutionary and functionalist theories provided evidence and insight for the formulation of new approaches. These works contributed to the formation of disciplines interested in the study of human-environment complexities.

CULTURE CHANGE, DIET CHANGE

Diet change goes hand in hand with culture change. Food has been used to understand cultural and societal change from the early days of anthropology (e.g. Richards, with seminal works such as Sweetness and Power (Mintz 1986), witnessing a boom in the past decade. Wilk

(2012) shows, however, the challenge of food studies as an interdisciplinary field, with potential to bridge fundamental differences in disciplinary assumptions of human nature. According to him, food studies carries the potential to engage with many epistemologies related to human behavior, by analyzing the overlapping of values and meanings of a society, group actions, as well as individual motivations.

Mimicking the trajectory of the studies of culture change and food studies exposed above, my attempt is to break away from a romanticized notion of a static food system, especially considering stereotypes associated with the rural Amazon. Taking instead an evidence based approach and the premise that food systems are dynamic. Because of that, I would argue for the use of terms such as resilient foods or locally sourced foods, as opposed to traditional foods. The term resilient foods have been used by Adams et al. 2012 in their discussion of the manioc-fish duo, since it represents an adaptive strategy for subsistence in the Amazon for at least two centuries.

This does not mean that these resilient foods have not been modified throughout this time, for example, being processed or prepared differently, consumed at various times during the day, and so on. Manioc flour, for instance, may well have grown in importance in certain areas of the Amazon, as opposed to other manioc sub products (e.g. *beiju*, *tucupi*, *tapioca*, etc.), concomitant with the rise of the rubber economy, starting in the late 1800s. Manioc flour is a product that can be stored for long periods of time and is an easily transported carbohydrate. Men could travel for long periods of times tapping rubber trees, often far from their settlements, knowing they would always have a source of energy available (Pinton and Emperaire 2000).

Weismantel (1988), for instance, lists a basic vocabulary in the diets of the Zumbagua indigenous people of Ecuador, focusing on materiality, and making connections to its use in the everyday life, and power and resistance. Also, in Mary Douglas (1972) inspirational work "Deciphering a Meal," she exposes meals as social events, which followed a framework of food categories, describing an overarching American diet structure at the time.

Another interesting analysis of food categories and meanings in the Amazon estuary is the concept of "validator food" (Weismantel 1988, 125). This status has been attributed to *açaí*, a local palm fruit, without which a dish is not recognized as a filling meal (Siqueira 1997). In the case of the Middle Solimões region presented here, this is not the case. While açaí is greatly appreciated in the Middle Solimões, it is still very seasonally consumed. Manioc flour, on the other hand, has historically been present in the diets of Amerindians, whites, slaves, and migrant populations in Brazil; is still the most important local staple in the Amazon (Murrieta 2001).

There is clear evidence to assert that calories matter and that diet is a fundamental component for an individual's growth, development and general wellbeing (e.g. Nestle and Nesheim 2012). However, researchers debate on the usefulness and accuracy of using health assessments recognizing a complex relationship between diets and physical status. For instance, the use of BMI as a proxy for good health and nutrition has many pitfalls. These have been explored both in the natural sciences (e.g. Nestle and Nesheim 2012) and in the humanities (e.g. Guthman 2011). Guthman (2011) presents a thorough discussion about the use of BMI and the harmful consequences of arbitrary changes in the cutoff points for entire populations (Guthman 2011, 24-45). Indeed, There is no causal confirmation of the direct link between obesity and diseases, but studies show an association between obesity and coronary artery disease, mortality from type 2 diabetes mellitus (T2DM), and endometrial, breast, and colon cancers (NIH 2013). Nonetheless, the reasons and ways in which changes in diets and food systems affect health trends still need extensive grounded research and quantification.

THE NUTRITION TRANSITION AND NUTRITIONAL ANTHROPOLOGY

The nutrition transition is a term coined in the nutrition science literature postulating, among other changes, that in recent decades, worldwide obesity levels increased drastically, along with a shift in the structure of diets towards a “westernization”, fundamentally involving an increase in the consumption of “saturated fat, sugar, and refined foods” (Popkin 1993a). Further development and use of the specific hypothesis above enabled researchers, from various disciplines, to investigate complex social, economic and cultural relationships involved in diet change.

In 1993, Popkin proposed five broad nutrition patterns aligned with human historical developments, characterized by: “Collecting Food” referring to a general diet of hunter-gatherers; “Famine” associated with a period of stress over food scarcity and social differentiation; “Receding Famine” in which a shift away from starchy staples in diets alleviate hunger and disease burden; “Degenerative Diseases” which discusses a shift in diets and physical patterns much like what is hypothesized in the most recent literature as characterizing a model of “nutrition transition;” and finally a pattern of “Behavioral Change,” a transition occurring in small scale towards preventing degenerative diseases associated with diets low in fat intake and industrially processed foods. These are characterized in broad terms including the composition of diets, societies’ food processing techniques and economic organization, as well as people's nutritional status (Popkin 1993). In later publications, Popkin collaborates with other authors naming the patterns above as "stages," mostly focusing on the last two. These authors acknowledge that these stages are flexible, varying in time scale, geographical areas, as well as with income levels. This idea of a progression is then putatively addressed from a broad perspective, considering factors such as changes in agriculture, health, and socioeconomic patterns (e.g. Caballero and Popkin 2002; Popkin and Gordon-Larsen 2004).

A model of nutrition transition as a series of stages has been criticized by anthropologists mainly because it falls short as a conceptual model for research when considering the available evidence of changes in diet. The model as stages is a limited platform for the analysis of variability across populations, but most notably to address variability within populations. For instance, country-level data through time may indicate a shift toward increase in animal food sources, but grounded studies might show high variability in consumption of these particular foods within populations. For example, evidence from diets of low income women in an urban setting in Colombia show that changes in diets for the last 20 years did not follow the nutrition transition predictions (Dufour, Bender, and Reina 2015).

I concur with the idea that the nutrition transition as a broad series of stages fails to capture the complex drivers and outcomes of dietary and physical activity change across and within populations at a fine scale. Moreover, economic, social, cultural and environmental interactions on the ground are often not unidirectional or progressive; therefore, by using stages as a model, researchers not only limit their analysis, but are prone to bringing in a westerner centrist view into play. For instance, facilitating stereotypical interpretations of certain diets or economies as backwards and vice-versa. Nevertheless, researchers from a variety of disciplines have dialogued with the nutrition transition model not as a series of stages, but as *a shift in the structure of diets, characterized by an increase in the proportion of energy coming from fat in diets (accounted mostly by vegetable oil), as well as an increase in the consumption of sugar, ready-to-eat processed foods, and food consumed away from home, accompanied by a shift in physical activity patterns to a sedentary lifestyle linked to obesity* (e.g. Monteiro, Conde, and Popkin 2004; Lourenço et al. 2008; Welch et al. 2009; Nardoto et al. 2011; Piperata, Ivanova, et al. 2011; Piperata, Spence, et al. 2011).

There are several examples of research postulating a replacement of minimally processed staples by convenient and cheaper industrially processed food items in diets globally, adding that detrimental health effects disproportionally affect the poor (Du et al. 2004; Monteiro, Conde, and Popkin 2007; Popkin 2009; Monteiro et al. 2013). For example, Monteiro et al. (2013) compare country-wide sales of ultra-processed snacks and soft drinks in Brazil, between 1998 and 2012, showing the highest relative increase in lower-middle-income countries (7.67% relative annual growth), and the lowest in upper-middle-income countries (1.22% relative annual growth). Moreover, Popkin, Adair, and Ng (2012) state that, even in middle and low income countries, "diets rich in legumes, other vegetables, and grains are disappearing," implying a replacement of previous diets by a "western" one. Most of these studies base their propositions on countrywide agricultural trade data as proxies for individual food consumption, or on data from governmental household surveys.

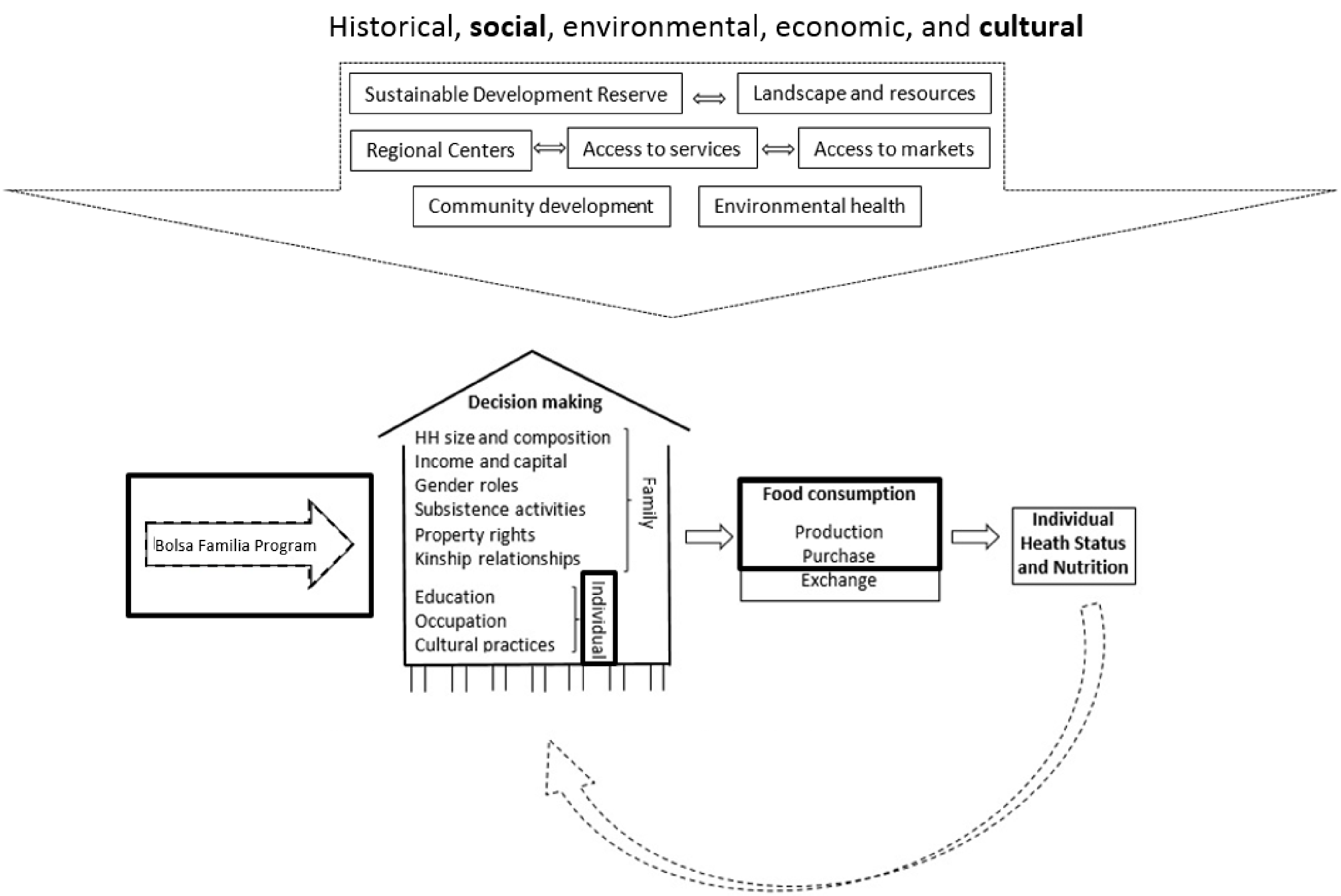


Figure 53. Dissertation framework with key elements for Chapter 4 highlighted

In this research, I use the nutrition transition referring to the propositions above which are heavily based and departed from ideas developed by Popkin in a series of publications (e.g. Popkin 1993a; Popkin 2001; Popkin 2004; Popkin 2009), however I am not considering it as part of a stage of development. I take the nutrition transition model in light of a nutritional anthropology conceptual model (Figure 54), building then a separate conceptual model for this dissertation, highlighting the variables of interest for this chapter (Figure 53). These variables are the basis for my analysis of the differences in the composition of diets of women participating and non-participating in the Bolsa Família Program.

In the nutrition science literature, the diet structure pertains mostly to percent energy from food intake coming from carbohydrates, fats and proteins (Drewnowski and Popkin 2009), as in the analysis conducted in chapter 2, as well as in part of chapter 5. Each of these macronutrients would every so often be further analyzed under subcategories such as complex carbohydrates and added sugars, vegetable fats and animal fats, as well as other variations, for example, dietary diversity (Drewnowski and Popkin 2009) and levels of industrial processing (Steele et al. 2016).

Industrial food processing procedures often entail the addition of salt, sugars, and a variety of vegetable oils, all responsible for diseases associated with the western diet exaggerations (Myles 2014). These have been associated with dysfunctional immune systems, inducing chronic inflammation (Simopoulos 2002), as well as with high blood pressure (Meneton et al. 2005). In addition, the industrial process of hydrogenation of vegetable oils have been linked to increase in of heart disease risk (Mozaffarian et al. 2006), and nitrates used in meat processing have been associated with increase of colorectal cancer risk (Hunter 2006).

Despite industrial processing being at the core of dietary shifts leading to detrimental health effects, this aspect of the food system has been widely understated in academia, as well as in applied sciences (Monteiro et al. 2016).

Expanding on concepts from nutrition science and anthropology, as defined above, here I refer to the structure of diets in a broad encompassing manner. While nutritional anthropology has started looking at shifts in diet structure under a broader framework, there is a dearth of studies like this one, contextualizing and linking diet change trends to the extent and purpose of food processing, local cuisine, and individual nutritional status.

Given that research models and framings are influential in the formation of policy, it is crucial that I lay out my research approach as outlined in this section (Figure 53). Diener, Moore, and Mutaw (1980) urge researchers to recognize that theoretical perspectives in academia can often be incorporated into policies and may therefore pose dangers. For instance, they point out how much the incorporation of the protein gap discourse in Amazonia cost in the fight against malnutrition due to the wrong use of policy tools. Guthman (2011), after a review on the history and use of BMI, argues that "linking specific disease attributes with particular identifiable populations runs the risk of excluding from care those who do not fit in the category 'at risk' and subjects who do fit to unnecessary surveillance" (Guthman, 2010:44).

Studies in nutritional anthropology research accepts the fundaments of the energy balance model (energy input from foods and body maintenance and physical work expenditure), evaluating health status and human development using biological measures, including anthropometry, nutritional adequacy based on nutrient requirement, and so on.

While the exclusive use of such measurements may fall short in understanding and informing policy, as mentioned above, their use within a larger framework of social, cultural, and economic dimensions to health has been recommended and shown to be instrumental in the literature (Coimbra Jr. et al. 2004; Piperata, Spence, et al. 2011; Silva et al. 2016). A nutritional anthropology conceptual model, as proposed by (Pelto, Dufour, and Goodman 2012), is an effort to build a comprehensive framework and base the interpretation of processes on grounded evidence.

The nutritional anthropology conceptual model (Figure 54) is useful because it focuses on diets as an outcome and cause of interactions between the social and physical environment, technology, culture, and social organization. Global forces are also present as an overarching element, and all relationships are bidirectional (Pelto, Dufour, and Goodman 2012). In stressing interactions, the concept of food system under this model is represented as a dynamic "totality of activities, social institutions, material inputs and outputs, and cultural beliefs within a social group that are involved with the production, distribution, and consumption of food" (Pelto, Dufour, and Goodman 2012).

Under this broad general model, the concept of human adaptation has been demonstrated as useful in a number of works. One classic example in the Amazon is the processing techniques of bitter manioc, otherwise toxic for consumption, which has become behavioral adaptation. Dufour (1995) shows that cooking or roasting manioc are not effective techniques in reducing cyanide concentrations in bitter varieties, but that the key aspect for detoxification is grating the root. As manioc processing was developed in a particular cultural and environmental context, once manioc was introduced in West Africa in the sixteenth century, inadequate processing was associated with the rise of a number of health problems (Dufour 1995).

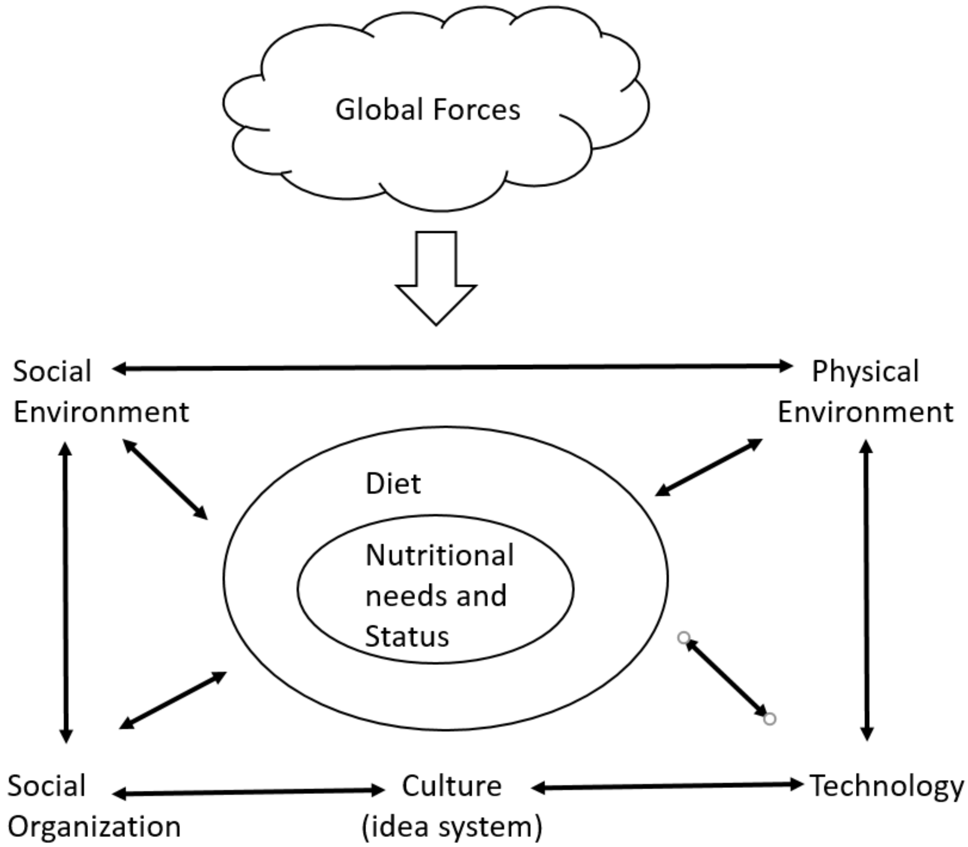


Figure 54. Nutritional Anthropology Conceptual Model (reproduced from Pelto, Dufour, and Goodman (2012)

While all research in nutritional anthropology is interested in the interactions between food intake (diets and nutrition) and social and cultural processes; many approaches do not use the concept of adaptation. Nutritional anthropologists also investigate the meanings of foods in different places and times, contemporary foodways, and the evolution of human diets (Dufour, Goodman, and Pelto 2013). Using this framework, Finnis (2009), for instance, focused on the decline in production and consumption of millets in South India, once common staple foods.

In Tamil Nadu, rice is becoming more common in diets, and manioc as a cash crop has contributed to reducing women's workloads (Finnis 2009). Even though millet varieties are more nutritive in terms of minerals and proteins, and are also important for maintaining agrobiodiversity and food security, most women are not interested in producing millet anymore. In nutritional anthropology, detailed ethnographic approaches such as exemplified in Finnis (2009) are instrumental in revealing the complexity between social-cultural processes and diets.

As the example above, the replacement of food staples linked to income rise among the poor have been studied mostly as consequences of market integration and cash cropping. When economic change comes as the expense of local food production, particularly in poor rural areas with limited infrastructure, nutritional consequences can be harmful to household members; however, mixed results have been found, depending on context, in terms of effects to nutrition (von Braun, Kennedy, and Bouis 1990). Nonetheless, research conducted using primary data linking health and decisions regarding money management are rare.

In Asia, secondary data from national household surveys show a decline in the consumption of rice, associated with income rise, especially among young people. Rural households also had a higher degree of industrially processed foods than expected. Combining data from Bangladesh, Indonesia, Nepal and Vietnam, rural households had 30% of the total food expenditure was with highly processed foods (Reardon et al. 2014). Again, using a governmental database from rural households in Malawi, Wood et al. (2013) analyze the decrease in maize production following the adoption of tobacco as a cash crop, and show a direct association between market price drops and stunting in children 6 to 59 months old. The factors associated with income and changes in the structure of diets, and researchers have identified context and household decisions as important variables to consider (von Braun, Kennedy, and Bouis 1990; Piperata, Ivanova, et al. 2011; Wood et al. 2013; Reardon et al. 2014).

Among the few available examples of literature using primary data focusing on the relationships between income and changes in diet structure among rural populations are Ulijaszek's (1993) work in Papua New Guinea, Piperata, Ivanova, et al. (2011) in the eastern Brazilian Amazon, and this study. There is some primary data on indigenous people of the Amazon also, mostly regarding market integration and nutrition (Godoy et al. 2005).

Ulijaszek (1993) documents the factors influencing diet change in Papua New Guinea focusing on wage earnings and cash cropping. He stresses the importance of changing females' roles, both influencing food production and purchase, showing a substitution of traditional foods used in village rituals, by chicken and even cheaper animal protein such as tinned mackerel and corned beef. Moreover, local starchy tubers had been largely replaced by rice He states that there "have been considerable improvements in the health and nutritional status of the people, but at a price." (Ulijaszek 1993, 204)

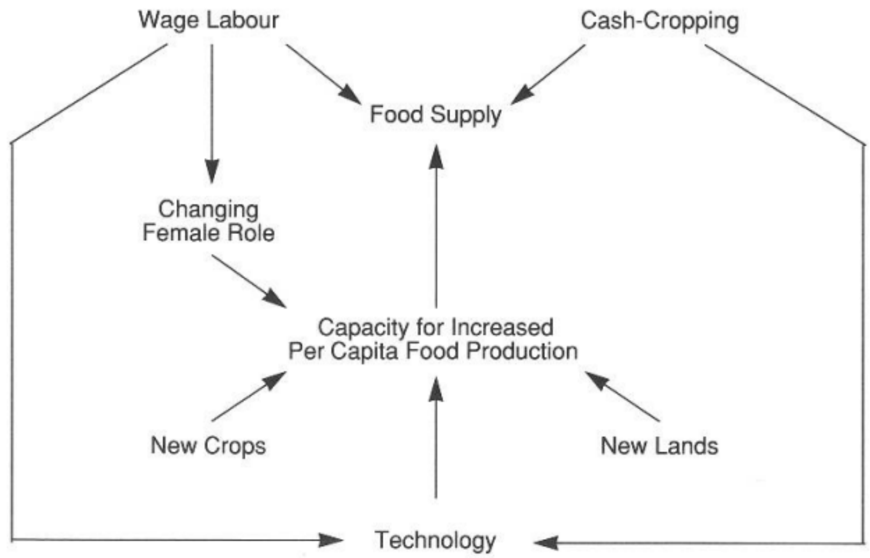


Figure 55. Factors influencing diet change (reproduced from Ulijaszek 1993)

This association with cash cropping might be similar to what happened in the Brazilian state of Pará, with the development of the açaí global economy. Locally, açaí evolved from a rural local staple to a major forest crop, with prices steeply rising , entering the regional urban markets, as well as nationally and internationally as a “super food” (Brondízio 2008), and provoking profound changes in diet patterns in Brazil (Padoch et al. 2008). Also in Pará, comparing the energy provided by açaí in diets of ribeirinhos, Piperata, Ivanova, et al. (2011), show that in 2002 the contribution of this item was 16% on average, declining to less than 5% in 2009. They suggest a shift to purchased foods in important energy sources for rural diets, especially rice, beans and crackers.

METHODS

THE MIDDLE SOLIMÕES: LIVELIHOODS AND DIETS

Data for this research were collected in households located in the Middle Solimões region, more specifically in the Amanã Sustainable Development Reserve. Most settlements at Amanã are located in upland areas, less affected by flooding compared to neighboring regions.

This is one of the reasons why agriculture, especially manioc production, is among the most important activities for its residents. Fishing for consumption and sale is also prevalent and social benefits, such as rural retirement, BFP benefit, and *seguro defeso* (allowances for fishermen during prohibition season), represent a significant portion of the household income for people living in Amanã (Peralta and Lima 2014).

These riverine peoples are commonly referred to in the academic literature as *caboclos*, and while the term carries differing meanings, including pejoratively, it has become a useful social category for political representation (Lima 1999; Brondízio 2008). Caboclos or *ribeirinhos,* the latter term used as self-identification in certain regions (Piperata 2007)*,* are generally used in the literature to describe descendants of indigenous inhabitants of the Amazonian floodplains and European colonists. Recent anthropological studies have pointed to an invisibility and lack of recognition for these populations' active entrepreneur abilities and achievements (Brondízio 2008) as well as a-historicity which prevails in most of the literature, neglecting the diversity of the local Amazonian populations (Nugent 1993).

As discussed in chapter 1, here I opt for using the term *comunitários* for Amanã residents, a commonly used self-denominating term. The productive activities of these comunitários are based on family relationships, aimed at subsistence and cash-income from agriculture, fishing and timber (Lima 2005; Peralta and Alencar 2009). Manioc flour, as a product for subsistence and exchange, has been key to the historical development of the Amazon (Pinton and Emperaire 2000) and women's participation, from the planting to manioc roots processing, is widespread (Murphy and Murphy 2013), including along the Middle Solimões (Peralta and Alencar 2009).

Rural Amazonian populations rely mostly on two staple foods: fish and manioc flour, however, consumption of industrialized foods has been documented since the 19th century. The *regatões* (trade boats) passed along the river collecting forest resources extracted by small holders, most notably rubber, and selling goods for high prices, creating a system of debt called *aviamento* (Lima 2005; Brondízio 2008). Trading was marked by an indirect connection with the market and personalized relationships with a buyer of particular products (Léna and De Oliveira 1991). As a consequence, to this date, populations living in rural villages purchase non-perishable foods meant to last for long periods, known as *ranchos* (Lima 2005). Today, ranchos are comprised of industrialized foods (sugar, cooking oil, coffee, etc.), cleaning products and fuel.

Amanã is mostly characterized by upland forests, although many fields are planted in seasonally flooded areas. The research was conducted predominantly in 3 communities, where most residents participated in the BFP. Households in which there were no members participating in the BFP were rare, presenting distance and time limitations for data collection, and involved residents of 14 different villages in Amanã. For these reasons data collection for nonparticipating households was limited, and done only with adult women in the household during one visit. Data collection in households participating in the BFP was longitudinal, involved various methods, and was conducted with adult women and adolescents throughout the year

OBJECTIVES AND HYPOTHESES

The main objectives of this chapter are to understand if BFP participant women had more industrially processed food items in their diets compared to non-BFP recipients, to assess the role of age in this process, as well as to evaluate if the inclusion of these food items characterized a change in the structure of diets.

To address the objectives above, the research design involved the comparison of dietary data collected in interviews with women who participated in the BFP and with women who lived in households where no members participated in the program, but were in the same income bracket as participants. Households in the communities studied predominantly participated in the program, and, as stated previously, it was rare to find non-participant households.

In order to find a sample of households which were nor part of the program I contacted the local Reference Center for Social Assistance (CRAS) at the town of Maraã. CRAS is responsible for managing the logistics of the BFP program at the municipal level, following the decisions of the federal government. They provided a list of households and their addresses, who were registered and awaiting to enter the program, since the municipality had reached the quota stipulated for BFP participants. The federal government stablishes a quota for each municipality based on population data from the Brazilian Institute of Geography and Statistics (IBGE).

Here I present a summary of the hypotheses, according to the list outlined in the section "Research problem: The Bolsa Família Program (BFP) and the nutrition transition."

As previously mentioned the industrial processing of foods was broken down into different levels. Levels of food processing were adapted given the context of the rural Middle Solimões, as well as based on the literature on the subject of industrial processing foods and health. Given the context, I opted for distinguishing foods processed locally, on site, and foods that were processed outside the household (purchased), even though they are not industrially processed. These is because some products, such as farinha, are locally sourced but require intense processing on site.

In order to operationalize food-processing levels I adapted the categories used by Monteiro et al. (2010) to the data collected for this research. A discussion of how these categories were applied is included in the "Categories of processed food items" section. Essentially levels varied from the least (group 0) to the most industrially processed (group 3). Levels ranged from Unprocessed or Minimally Processed at Home (group 0), such as fruits, nuts, vegetables, farinha and grilled fish, to Ultra Processed Food Products (group 3), such as soft drinks, canned meat and fish, sausages and candies.

Hypothesis 1.1, 1.2 and 1.3 address the question of:

Question 1: Are women living in households participating in the BFP consuming processed foods more frequently than women living in households not participating in the program?

Hypothesis 1.1: Women living in households participating in the BFP consume unprocessed or locally processed foods (group 0) less frequently than women living in households which are not part of the program;

Hypothesis 1.2: Women living in households participating in the BFP consume food industry ingredients and ultra-processed foods (groups 2 and 3) more frequently than women living in households which are not part of the program;

Hypothesis 1.3: Women living in households participating in the BFP consume ultra-processed foods (group 3) more frequently than women living in households which are not part of the program;

Hypothesis 2.1 and 2.2 respond to:

Question 2: Are women living in households participating in the BFP consuming purchased foods more frequently and local stables and snacks less frequently than women living in households not participating in the program?

Hypothesis 2.1: Women living in households participating in the BFP will more frequently consume purchased rice, crackers, breads, chicken, and beef, than women living in households which are not part of the program;

Hypothesis 2.2: Women living in households participating in the BFP will less frequently consume locally sourced foods such as farinha, manioc products, fruit, fish and game, than women living in households which are not part of the program.

Hypotheses 3.1, 3.2, and 3.3 refers to the question of:

Question 3: Are young women consuming processed foods more frequently than older women?

Hypothesis 3.1: Younger women consume unprocessed or locally processed foods (group 0) less frequently than women living in households which are not part of the program (controlling for BFP participation);

Hypothesis 3.2: Younger women consume food industry ingredients and ultra-processed foods (groups 2 and 3) more frequently than women living in households which are not part of the program (controlling for BFP participation);

Hypothesis 3.3: Younger women consume ultra-processed foods (group 3) more frequently than women living in households which are not part of the program (controlling for BFP participation);

The methods used to address the hypotheses listed above were 24-hour dietary recalls and dietary assessments to evaluate food consumption of women and adolescents, as well as a census interview with demographic, social and economic information and participant observation.

DATA COLLECTION

The census interviews were conducted by me or by an assistant always accompanied by me. In each household, we used a structured questionnaire to collect data on demographics, including household composition, age and education. Data about main economic activities, sources of income and social benefits received were also included, as well as variables on food production, consumption, frequency and places for food purchase and exchange within the community. The interview lasted for about 15 to 40 minutes depending on the size of the household.

I conducted all 24-hour dietary recalls with participants, but the procedure and instruments used with BFP beneficiaries were more detailed than the ones used with non-beneficiaries, given the higher financial, transportation and time limitations to reach participants for the latter sample. By the same token, participant observation was conducted only in the communities where BFP participant women lived, requiring a longer timeframe. I was either living in the community or nearby.

In the BFP participating sample I conducted 24-hour dietary recall data with 41 individuals, of which 18 were women, between the ages of 29 and 54, and 23 adolescents between 12 and 15 years old. The dietary recalls were intended to be performed with all participants for 2 non-consecutive days (as recommended in (IBGE 2010), and 3 times during the year (in April/May 2014, August/September 2014, and December of 2014/January of 2015) in order to understand diet variation throughout the year (Table 46). This was ideal given the variability in environmental conditions, which highly affect agricultural production and transportation in the region. Given the time and dedication required for data collection and difficulties in finding participants during the planned dietary assessment periods (and other variables such as pregnancy and drop out), only 28 of the 41 individuals completed 6 recalls during the year. Of the total, 5 individuals and 6 individuals completed 5 and 4 dietary recalls respectively, and 2 individuals completed only 2 recalls during the time of data collection.

For conducting the dietary recall with BFP participants, clear instructions were given to all individuals one day before every data collection performed. I went to the person's house two days before the 24-hour recall interview was to be conducted to explain the purpose of the activity and to hand in a pencil and recording form for annotation of foods eaten the next day (from rising to bedtime). The form included blank slots to be filled out and some pictures of the most common foods eaten in the region. The individual was encouraged to fill out the form as they preferred, either writing the name of all ingredients in the foods consumed (when known) and amounts eaten, or drawing them (in cases of low literacy levels). In the first visit, I showed a "24-hour food recall kit" (composed by a food scale, modeling clay, ruler, utensils and graduated containers) that would be used to estimate food amounts consumed so the respondent would get familiar with the methods. Also, I emphasized the importance of not changing consumption as a result of this activity, as well as careful recording of ingredients in the foods eaten in the maximum possible detail.

Table 46. Bolsa Família Program participants: sample size for each 24-hour dietary recall data collection period

Data collection period	Women age 29-54	Adolescent females age 12-14	Adolescents males age 12-14
April/May 14	18[a] (36 recalls)	9[b] (18 recalls)	14[c] (28 recalls)
Aug/Sept 14	18[a] (34 recalls)	9[b] (18 recalls)	14[c] (28 recalls)
Dec/Jan 15	14[d] (27 recalls)	8[f] (16 recalls)	11[g] (19 recalls)

[a] Missing data on 1 woman who did not consent, [b] Missing data on 3 female adolescents, 1 whose mother did not consent, 1 who was still 11 years old, and 1 who did not live in the community yet; [c] Missing data on 1 male adolescent whose mother did not consent; [d] Missing data on 2 women, 1 who did not consent, 1 who travelling to study; [e] Missing data on 3 women, 1 who was pregnant and 2 who were travelling to other communities; [c] Missing data on 4 male adolescents, 1 whose mother did not consent, 1 whose mother was travelling to study and 2 whose mother was travelling to other communities.

Individual interviews were conducted two days following the first visit, at a time agreed upon with the respondent. During the 24-hour recall interview I recorded foods and amounts following Gibson and Ferguson (2008) guidelines for the use of this method in developing countries. The respondent used the annotation form to help with remembering the last day of consumption, but was also encouraged to remember daily activities to recall if any food items were not registered on the form. I conducted the interview starting with a first pass (list of all foods and drinks in chronological order); a second pass (review list in chronological order with neutral probing); a third pass (estimating portion sizes – direct weighing was used when possible, but weight conversion of measurements made with food recall kit was also used); a recording of recipes and food preparation; and finally, a review of all foods cited, probing for any possible forgotten items. Usually at the end, either a new recording form would be given or the next visit for the form drop-off would then be scheduled, in accordance with the time availability of the respondent.

For non-BFP participating sample, the Maraã municipality CRAS provided me with a list of 20 women living in households that were approved and met the BFP conditionalities, according to their assessment, but were not contemplated yet and were waiting to receive the benefit. I left with an assistant who drove the motorized canoe starting with the communities which were closer to the communities in which the BFP participating women lived. Given that the list provided was not updated and many families had moved in and out of these communities I opted for stopping in every community we passed by, talking to the leaders and active looking for potential research participants. Using this approach, I conducted interviews with 25 women in 14 communities and 2 dispersed localities in Amanã during three weeks between October and December of 2014. The average age of the women interviewed was 28.4. Households not participating in the program were, in general, newly formed, mostly characterized by young couples with newborns. In eight of the 25 households, participants were 18 or younger, three participants, the youngest ones in the sample, were 15 year olds.

Table 47. Non-Bolsa Família Program participants: sample size for dietary assessments

Data collection period	**Women age 15-68**
Oct/Dec 14	25

The dietary assessment interviews with non-BFP participants were conducted on the first encounter with the woman who agreed on participating in the research. Although the purpose of the interview was explained, no recording forms or “24-hour food recall kit” were used. The interview was conducted only recording food items, but no quantities. These dietary assessments were conducted once with each participant, again following guidelines of questions and probing (Gibson and Ferguson 2008). The interview started with a detailed list of all foods and drinks consumed in the previous day, in chronological order. Then this list was reviewed, again in chronological order with neutral probing. Next I recorded any necessary recipes or food preparation, and finalized with a second review of all foods cited, probing for any possible forgotten items.

Sample sizes: number of food items in dietary recalls and diet assessment

To examine the relationship between participating in the BFP and consumption of processed foods I compared food items of differing processing levels present in dietary recalls among BFP participants and non-participants. Given that data on the non-beneficiaries group was collected once during the dry season, data collected exclusively in this same season for the beneficiaries' sample was used. Also, only recalls that were classified as typical days by the respondents were considered for this analysis. The data used in the section entitled "The effect of Bolsa Família and age on consumption of processed food items" (Table 48) are composed of:

- BFP participants: food items in dietary recalls conducted with 14 women between the ages of 29 and 50. There were a total of 20 recalls which were identified by them as representative of a typical day (7 women had atypical day recalls), categorized using the food items as (Table 53) amounting to a total of 406 items with an average of 20.3 items per dietary recall. The recalls were to be repeated with all women, but due to research limitations, only six were done.
- Non-BFP participants: food items in dietary recalls conducted with 25 women between the ages of 15 and 68. There were a total of 23 recalls which they identified as representative of a typical day (2 women had atypical day recalls), categorized using the food items as listed in Table 53, coming to a total of 406 items, with an average of 17.6 items per dietary recall. The recalls were not repeated given the limitations on distance to households in the field site.

Table 48. Summary of participants and dietary recalls (dry season)

Participants	Age	Number of participants	Number of recalls (typical days)	Total food items
Women participating in BFP [1]	29 - 50	14	20	406
Women not participating in BFP [2]	15 - 68	25	23	406

[1]Two atypical recalls (not included); [2]Seven atypical recalls (not included).

DATA ANALYSIS

The initial analysis comparing number of food items in each food processing category between BFP participants and non-participants was performed using a Pearson's chi-square test of independence, followed by a series of logistic regressions looking at the effect of BFP in the number of processed food items recorded in recalls, controlling for age of participant. Logistic regressions were also used to investigate the effect of age on consumption of processed foods among BFP participants. All statistical analyses were conducted using R version 3. 2. 2 (R Core Team 2015).

To understand if BFP recipients were consuming more processed food items in their diets compared to non-BFP recipients I classified all food items recorded on 24-hour recalls into food groups consisting of different levels of processing. They were adapted from previous categories used by Monteiro et al. (2010) to classify Brazilian dietary data (Table 49).

Categories of processed food items proposed by Monteiro et al. (2010)

Monteiro et al. (2010) classification includes three main food groups, Groups 1, 2 and 3, categorized according to the extent and purpose of processing. According to them, this classification was "designed as a tool to describe food systems and dietary patterns, and how this may affect health and the risk of disease" (Monteiro et al. 2010: 2040). The groups are:

Group 1 or "unprocessed or minimally processed foods": this group is comprised mostly of **physical processes** from cleaning and packaging to freezing and pasteurizing foods. The purpose is of preserving and/or making foodstuffs safer for consumption. Some examples are frozen vegetables, plain yogurt and milk.

Group 2 or "processed culinary or food industry ingredients": this group includes physical and chemical processes to obtain **food ingredients** used in preparation of foods, often not consumed alone. They point out these foods are usually high in energy content but low in nutrient density compared to group 1 foods. Some examples are vegetable oils, sugar and flours.

Group 3 or "ultra-processed food products": this group includes **ready to eat** foods which are a result of several processes, such as salting, frying or canning. Foods in group 3 are frequently include added preservatives and sophisticated packaging. These food items are often described as convenience foods or fast foods. Some examples are breads, soft drinks and processed meats.

Monteiro et al. (2010) suggests that when using their classification with food intake survey data, that recipes be broken down to each ingredient, for dishes prepared in restaurants or at home. Here I opted for not breaking down all recipes to single ingredients, but to consider aggregated data for food processing in the household, when it involved cooking. This is because the research interest here is also in understanding how these foods are incorporated in diets at the household level, in the context of the Middle Solimões.

Food processing categories in context

Given that in the rural communities studied, subsistence activities, such as agriculture and fishing, are central to livelihoods, I opted for adapting Monteiro et al. (2010) categories. Besides understanding different levels of processing, I also considered where the processing occurred, in site or outside the communities. The groups were divided in terms of minimal processing, home preparation, and industrial processing, ranging from a lower (group 0) to a higher (group 3).

Group 0 includes foods that are unprocessed or processed in site and is referred to here as **unprocessed or locally processed foods**; **Group 1** is referred throughout as **locally prepared foods and purchased dried goods** and includes both foods processed outside the home or home-prepared foods requiring minor proportions of industrially processed ingredients (combinations of group 0 and group 2). Considering the lower processing range, group 0 and group 1 assist with distinguishing foods that are unprocessed or completely sourced in site (group 0), from the presence of foods which require minimal outside processing or inclusion of small proportions of these items in meal preparation (group 1). The difference between groups 0 and 1 reflect an addition of outside processing to the items sourced locally, including packaging and physical processing (e.g. purchased rice and beans).

Group 2 is here referred to as **food industry ingredients and** includes ingredients used in home-prepared foods composed of simple additions without any preparation, such as sugar and dairy powder[21] in coffee, or margarine in boiled manioc or cracker. **Group 3** is here referred

[21] Dairy powder refers to *preparado láctio*, which according to Brazilian regulations (IN 28 published in June 12 of 2007), is a product containing at least 51% of dairy products (of the total mass weight of the product) and other non-dairy substances which are suitable for human consumption.

to **ultra-processed foods**, and is comprised of ready to eat foods requiring no preparation, such as soft drinks, crackers, breads, cheeses, and processed meat. Considering the later end of the processing spectrum, differentiating groups 2 and 3 assist not only in evaluating the level of industrial processing present in diets, but a complete replacement of preparation of a snack or an important part of a meal (e.g. canned fish or canned meat).

The relationship between Monteiro et al. (2010) classification and the classification used here is summarized in Table 49. Essentially, all foods placed here in group 0 would belong to group 1 in Monteiro's classification. The foods here placed in group 1 would either belong in the same group or be broken down into various ingredients, with the core ingredient belonging in group 1 and the others belonging in group 1 and/or group 2 in Monteiro et al.'s classification. The foods placed in groups 2 and 3 would not vary between the classification used in this research and in Monteiro et al.'s classification.

FOOD PROCESSING CATEGORIES IN CONTEXT

The data presented here represents the number of times a food item was mentioned in a dietary recall. Details on the initial sorting and grouping are justified below. Table 50 shows the accounted food items (data from all participants from typical and atypical days.

For the food classification, items that were rarely consumed alone and mostly as part of cooked meals were grouped as a recipe item. For instance, salt was not listed as an item, even though it was widely consumed as a condiment. Salt was present in a few of the foods included in Groups 0, such as in grilled fish and chicken, and in boiled vegetable roots. In Group 1 almost all foods had salt as an ingredient in preparation. The quantity of salt in recipes was measured only for a few cases and extrapolated for all others, so variability in quantity of consumption was compromised by data collection. Vegetable oil was also disconsidered as a sole item, but recipes with main ingredients of Groups 0 or 1 containing this product were all placed in Group 1, such as meats sauces or fried bananas.

Table 49. Food classification according to the extent and purpose of food processing, Monteiro et al. (2010) and categories adapted to the Middle Solimões context.

Definitions: extent and purpose of processing	**Group 0**	**Group 1**	**Group 2**	**Group 3**
This research	Unprocessed or locally processed foods (unprocessed or locally processed foods)	Locally prepared foods and purchased dried goods (minimally processed in industries or prepared local dishes)	Food industry ingredients	Ultra-processed foods
Food examples in this research	Manioc flour; all fruits; grilled fish and chicken; brazil nut; dried beef; and corn	Coffee; fried fish and meats, and stews; rice; porridges; fried manioc; manioc cake	Chocolate powder; condensed milk; cream; margarine Dairy powder; pasta sugar	Crackers, breads, ice pop; cookies; candies; cheeses; soft drinks; canned meat and sardines;
Monteiro et al. 2010	N/A	Unprocessed or minimally processed foods	Processed culinary or food industry ingredients	Ultra-processed food products
Food examples in Monteiro et al. classification	N/A	Fresh and frozen fruits; fresh, frozen, and dried beans; coffee; poultry and fish	Vegetable oils; margarine; sugar; salt; starches, flours, “raw” pastas; high fructose corn syrup; lactose	Breads; biscuits (cookies); cakes and pastries chocolates; Candies; cheeses; soft drinks; processed meat; fish canned in oil

Table 50. Food items in dietary recall data for all participants, including adolescents, from typical and atypical days, classified according to the extent and purpose of food processing, adapted from Monteiro et al. (2010) categories.

Group 0: Unprocessed or locally processed foods (48 items)	**Group 1: Locally prepared foods and purchased dried goods (30 items)**	**Group 2: food industry ingredient (10 items)**	**Group 3: ultra-processed foods (35 items)**
Abacaba	Banana/plantain (fried)	Chocolate powder	Canned meatballs
Avocado	Banana/plantain porridge [5]	Condensed milk	Canned meat
Abiu	Beans (purchased)	Dairy powder	Canned peas and carrots
Açaí	Beef stew	Heavy cream	Canned sardines
Apuruí	Beef fried	Margarine	Cheese
Banana (raw or boiled)	Chicken stew	Milk dried	Cheese bread [15]
Buriti	Chicken (fried)	Pasta	Chewing gum
Cacao	Coffee	Sugar	Chocolate bar
Cashew	Corn cake [6]	Tomato paste	Cookie [16]
Citrus (lemons and oranges)	Corn flour cake [7]	Wheat dough fried [14]	Cookie with filling [17]
Coconut	Corn porridge [8]		Corn puffs
Cubiu	Cupuaçu sweet		Cracker
Cupuaçu	Egg (fried)		Egg bread
Guava	Fish stew		French bread
Ingá	Fish (fried)		Guava paste [18]
Jambo	Fish sauce		Ham
Jenipapo	Game stew		Hot pepper sauce
Mango	Game (fried)		Ice cream
Marimari	Manioc starch cookie [9] (fried)		Ice pop
Melon	Manioc dough (fried) [10]		Yogurt
Pineapple	Manioc (fried)		Ketchup
Tucumã	Manioc cake [11]		Lollipop
Watermelon	Oat porridge [12]		Mint candy
Beans (produced)	Popcorn		Mucilon porridge [19]
Beef (dried)	Rice		Noodle soup

Brazil nut	Rice porridge [13]		Sausage stew
Carrot	Shrimp stew		Sausage fried
Coconut water	Shrimp fried		Soda
Corn	Wild bird stew		Flavored drink (juice powder)
Cucumber	Wild bird fried		Sweet bread
Chicken (grilled)			Sweetener
Egg (boiled or raw)			Toast
Fish (grilled)			Wafer cookie
Lettuce			Wheat cake
Manioc (boiled)			White bread
Manioc flour [1]			
Manioc sauce [2]			
Manioc starch bread [3]			
Manioc starch flour [4]			
Maxixe			
Plantain (boiled)			
Potato (boiled)			
Seasonings (various greens)			
Squash (boiled)			
Sugar cane juice			
Tea (various leaves)			
Tomato			
Yam (boiled)			

Common local names: [1] farinha, [2] tucupi, [3] beiju, [4] tapioca, [5] mingau de banana, [6] pamonha, [7] cuzcuz, [8] mingau de milho, [9] biscoito de polvilho, [10] frito de massa, [11] bolo de macaxera, [12] mingau de aveia, [13] mingau de arroz, [14] frito de trigo, [15] pão-de-queijo, [16] bolacha doce, [17] bolacha recheada, [18] goiabada, [19] mingau de mucilon.

Table 51. Food items in dietary recall data for women during typical days, classified according to the extent and purpose of food processing, adapted from Monteiro et al. (2010) categories.

Group 0: Unprocessed or locally processed foods (25 items)	**Group 1: Locally prepared foods and purchased dried goods (20 items)**	**Group 2: food industry ingredient (7 items)**	**Group 3: ultra-processed foods (16 items)**
Abacaba	Banana/plantain (fried)	Chocolate powder	Canned meat
Avocado	Banana/plantain porridge [5]	Dairy mixture	Chewing gum
Açaí	Beans (purchased)	Margarine	Cookie [16]
Banana (raw or boiled)	Beef fried	Milk (dried)	Corn puffs
Citrus (lemons and oranges)	Chicken stew	Pasta	Cracker
Mango	Coffee	Sugar	French bread
Melon	Corn flour cake [7]	Wheat dough fried [14]	Hot pepper sauce
Pineapple	Corn flour cake [7]		Ice pop
Watermelon	Corn porridge [8]		Ketchup
Beef (dried)	Cupuaçu sweet		Noodle soup
Cashew	Egg (fried)		Sausage fried
Chicken (grilled)	Fish stew		Soda
Corn	Fish (fried)		Flavored drink (juice powder)
Egg (boiled or raw)	Fish sauce		Sweet bread
Fish (grilled)	Game stew		Sweetener
Manioc (boiled)	Game (fried)		Toast
Manioc flour [1]	Manioc (fried)		
Manioc sauce [2]	Manioc starch cookie [9] (fried)		
Manioc starch bread [3]	Popcorn		
Manioc starch flour [4]	Rice		
Maxixe			
Seasonings (various greens)			
Squash (boiled)			
Tea (various leaves)			
Tomato			

RESULTS

This section provides a description of the diets according to the different levels of processing. All dietary recall data was incorporated in this analysis, including BFP participants and non-participants, women, adolescents, typical and atypical days, and data collected during all seasons.

GROUP 0: UNPROCESSED OR LOCALLY PROCESSED FOODS

Seasonings were used in relatively small quantities in recipes. These included ten items all grouped into one food category, with common names as *alfavaca* (wild sweet basil), *chicória* (Mexican coriander), *cheiro-verve* (cilantro), *couve* (collard greens), *cuminho* (cumin), *cebolinha* (green onions), *pimenta cheirosa* (yellow lantern chili), *pimenta do reino* (black pepper), *pimenta ardosa* (various types of chili peppers), and *urucum* (achiote). These were present in most of the preparation of meats included in group 1. The game category included *cotia* (agouti), *macaco guariba* (howler monkey), *paca* (spotted paca), *peixe-boi* (manatee), *veado* (deer), *tracajá* (yellow spotted river turtle), *jacaré* (caiman), *catitu* (peccary), and wild birds (including *mutum*, *macucaua*, *alencorne*, *ariramba*, *pato do mato*, *jacamim*, and *marreca*).

Looking at the frequency of a food item in each dietary recall for all interviewed subjects (including adult women and adolescents, BFP participant and non-participants) seasoning was the most frequent item mentioned in the unprocessed or locally processed foods group (48.6% or 1003/2065) given that it was counted each time one of the ten items grouped under this category was used. Seasonings are used in small quantities for flavoring, and are not a core element in terms of energy provision. As a single item manioc flour was by far the most common food item in this group accounting for 25.5% of all items (526/2065), as well as the most common single item considering all groups, 11.4% of all items mentioned (526/4624).

Fruits were also quite significant in this group (14.5% or 300/2065). In the fruit category bananas and plantains were the most frequent (4% or 83/2065) followed by açaí (3% or 60/2065). The next most frequent items were boiled manioc (1.7%) and beiju or manioc starch bread (1.5%), again indicating the importance of manioc as a food crop in this group of unprocessed or minimally processed foods at home.

Seasonings, manioc flour and fruits make up 88.6% of the items included in the unprocessed or locally processed foods group, in terms of frequency of consumption. Unprocessed or locally processed foods comprised the largest absolute number of items mentioned, almost half (44.7%) of all food items mentioned, showing a great contribution in frequency of consumption.

The importance of farinha

Farinha is a local staple, representing the most important source of kilocalories, and being used as cash crop by a large part of participants. The steps involved in the processing of the manioc root into flour in the communities studied are summarized in Figure 56. There was some variation in this process especially regarding grinding the manioc and draining the dough. Figure 56 shows the use of a motor for grinding, but when not available, it was replaced by a sieve, requiring additional time and labor. The *tipiti*, also shown on Figure 56, for draining the dough, was often replaced by a press squeezer. Moreover, most people would mix in a small quantity of pealed and grinded manioc (not soaked) to the dough before the draining process, which they referred to as *massa*.

Figure 56. Farinha production.

The time from planting to harvest varies from a few months to more than a year, depending on the variety and on the urgency of production for sale, consumption, and/or environmental factors such as flooding. The area preparation, planting, attending and uprooting of tubers require intense labor and is all done with minimum use of implements. For the processing, considering the work of 7 adults in a ca*sa de farinha*, where large toasting pans and other necessary structures are built (usually near the manioc fields and a small body of water for soaking tubers), during 10 continuous hours, an average of 5 farinha sacs are produced, equivalent to 275kg (~ 55kg per sac).

GROUP 1: LOCALLY PREPARED FOODS AND PURCHASED DRIED GOODS

The ingredients for other recipes included in group 1 were:

1. Banana/plantain porridge: bananas or plantains, sugar, salt, and water (dairy powder occasionally added);
2. Corn cake: grinded corn, sugar, salt and vegetable oil;
3. Corn flour cake: corn flour, sugar, salt, margarine, water (dairy powder or coconut milk occasionally added);
4. Corn porridge: corn, sugar, salt, water and dairy powder (dairy powder occasionally added);
5. Manioc starch cookie: manioc starch, eggs, vegetable oil, salt (Brazil nut occasionally added);
6. Manioc dough fried: grinded manioc, eggs, vegetable oil and salt;
7. Manioc cake (baked): grinded manioc, sugar, vegetable oil, margarine, and salt;
8. Oat porridge: oats, sugar, salt, water and dairy powder;
9. Rice porridge: rice, sugar, salt, water and dairy powder (dairy powder occasionally added).

Group 1 included foods minimally processed in industries (e.g. coffee, rice, beans, etc.) or dishes cooked at home with small quantities of food industry ingredients (e.g. sugar, vegetable oil, dairy powder, etc.) The most frequent item in this group was brewed coffee, representing 29.3% of all items (365/1245). Coffee drinking is widespread in the communities, consumed widely among adults and children. It is always brewed and consumed with the addition of sugar, and sometimes dairy powder. The average proportion of these ingredients in the preparation of coffee drinks was 1.2g of coffee powder for 8.5g of sugar in 100ml of water. This is equivalent to about 2 full tablespoons of sugar on the regular small size coffee cup served in U.S shops (350ml).

The second most frequent item in this group was fish stew and fried fish (25.4% or 316/1245), both prepared with vegetable oil. Fish represented the most important source of protein, as discussed in Chapter 2. Most meats were prepared with the addition of vegetable oil and therefore were largely included in group 1 of Locally prepared foods and purchased dried goods. In terms of animal protein consumption frequency, fish was followed by fried chicken and chicken stew (3% or 44/1245), then fried game and game stew (2.5% or 31/1245), fried eggs (1.8% or 22/1245), beef (1.7% or 21/1245), and finally shrimp (0.4% or 6/1245).

Rice was the third most frequent item in Group 1 (15.4% or 192/1245) followed by fried bananas and plantains (9.4% or 117/1245). Also, all porridges accounted for 2.6% (32/1245) of the foods mentioned, and all manioc recipes, including manioc starch cookie, manioc cake, fried manioc dough and fried manioc accounted for 2.3% (29/1245) in this group. In group 1 four items alone, brewed coffee, prepared fish, rice, and fried bananas, represented 80% of all items included.

GROUP 2: FOOD INDUSTRY INGREDIENTS

Group 2 of food industry ingredient is composed of only ten items in total. This shows how in the overall diet there are few of these items, compared to other Food Groups. However, it is important to note that vegetable oil is not shown here as it is being considered as part of recipes, so included mostly in group 1.

The most frequent food item in this group is sugar, accounting for 54.5% (413/757) of all processed culinary and industry ingredients mentioned in dietary recalls. The second most frequent food item of Group 2 mentioned was dairy powder (21.7% or 164/757). Dairy powder was used as an ingredient in snacks cooked at home (included with Group 1 items), and was often added to coffee and less frequently to fruit juices (included in this group). All additions of this ingredients which did not involve preparations through heating were included in this group

The next most frequent food item was pasta (7% or 51/757), a food item which was unfrequently consumed specially compared to rice and manioc flour. While manioc flour accounted for 11.4% (526/4624) of food items in terms of frequency of consumption, rice accounted for 4.1% (192/4624) and pasta 1.1% (61/4624). Sugar and dairy powder were the most significant consumed items of Group 2 in terms of frequency, and accounted for 76.2% of all items in group 2.

Table 52. Summary of frequency of consumption of food items by processing group level.

Group of processing level	Frequency of consumption (women and adolescents)				Example figures
	Food items	*All participants*	*% within group*	*% overall*	
Group 0: Unprocessed or locally processed foods	Seasoning	1003	48.6%	21.7%	
	Farinha	526	25.5%	11.4%	
	Fruits	300	14.5%	6.5%	
	Boiled manioc	35	1.7%	0.8%	
	Beiju	31	1.5%	0.7%	
	Others	170	8.2%	3.7%	
	All food items in group 0	2065		44.7%	
Group 1: Locally prepared foods and purchased dried goods	Coffee	365	29.3%	7.9%	
	Fish (fried or stew)	316	25.4%	6.8%	
	Rice	192	15.4%	4.2%	
	Fried bananas	117	9.4%	2.5%	
	Chicken (fried or stew)	44	3.5%	1.0%	
	Porridges	32	2.6%	0.7%	
	Game (fried or stew)	31	2.5%	0.7%	
	Manioc recipes	29	2.3%	0.6%	
	Others	119	9.6%	2.6%	
	All food items in group 1	1245		26.9%	

Figure 57. Boy carrying a coconut

Figure 58. Fish stew inside cooking pot

Group 2: Food industry ingredients	Sugar	413	54.6%	8.9%
	Dairy powder	164	21.7%	3.5%
	Pasta	51	6.7%	1.1%
	Others	129	17.0%	2.8%
	All food items in group 2	757		16.4%
Group 3: Ultra-processed foods (ready-to-eat)	Crackers	53	7.0%	1.1%
	Juice powder	28	3.7%	0.6%
	Bread	23	3.0%	0.5%
	Ice pop	22	2.9%	0.5%
	Others	253	33.4%	5.5%
	All food items in group 3	357		7.7%
Total		4624		

Figure 60. Girl eating açaí with added sugar

Figure 59. Canned meat sold in the community

GROUP 3: ULTRA-PROCESSED FOODS

Group 3 of ultra-processed foods was comprised of 35 different items, the second largest in terms of variety (Table 50) potentially adding diversity to diets. However, this group had the smallest absolute number of items mentioned, a total of 357. This was including typical and atypical days (usually days when people had visited towns or gone to parties in other communities). In group 3, 37% of the items mentioned in terms of frequency were crackers (7% of total items) which are consumed mostly during breakfast and often as a substitute for bananas which are commonly consumed fried in the morning. The most frequent items following the consumption of cracker in Group 3 represent a small portion of the total, given the diversity of items in this group. The next most frequent is artificially flavored drink or juice powder (8% or 28/357), then French bread (6.4% or 23/357), and ice pop (6.2% or 22/357). The last two were occasionally sold by residents at the communities.

THE EFFECT OF BOLSA FAMÍLIA AND AGE ON CONSUMPTION OF PROCESSED FOOD ITEMS

Initially, a Pearson's chi-square test of independence was performed to examine the relationship between participation in the BFP and consumption of industrially processed foods. The groups of food items with different levels of processing were categorized to investigate whether there were statistical differences in comparisons between participation or not in the BFP. The results from this comparison between frequency of food items in diets of BFP participants and non-participants should be interpreted with caution given that samples are unbalanced in terms of age range. Ideally, one could use propensity score matching to account for the difference in age between both samples, but given the small sample sizes, this is not an option for this data. As mentioned previously, data collection was limited by financial and time constraints. However, age was used as a covariate in the models presented and the testing of simple models with age alone as a co-variate gives a good indication of its significance in explaining differences in frequency of consumption of food types.

Comparing consumption of group 0 with all other groups combined, results suggest that BFP participants are consuming group 0 foods less frequently than non-participants, c^2 (1, N = 812) = 3.33, p =0.06. There is a 6% chance that the lowest consumption of unprocessed or locally processed foods (group 0) by BFP participants compared to non-participants is due to chance alone. This result signals that this difference should be further explored. For all other hypotheses, no statistical difference between BFP participants and non-participants was found (Table 53), comparing frequency in consumption combining **group 0 and 1** compared to **2 and 3**, and combining groups **0, 1, and 2** compared to **3**.

Table 53. Number of items in each food-processing group by women, Bolsa Família Program participants, and non-participants.

Group of processing level	**BFP participant women**		**Non-BFP participant women**		
	Absolute frequency	*%*	*Absolute frequency*	*%*	*p* values (chi-square)
Hypothesis 1.1					
Group 0	182	44.8	209	51.5	0.06 .
Groups 1, 2, and 3	224	55.1	197	48.5	
Total	406		406		
Hypothesis 1.2					
Groups 0 and 1	298	73.4	310	76.3	0.37
Groups 2 and 3	108	26.6	96	23.6	
Total	406		406		
Hypothesis 1.3					
Groups 0, 1, and 2	376	92.6	380	93.6	0.68
Group 3	30	7.4	26	6.4	
Total	406		406		

p statistics: ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Looking for the same relationships concerning participation in the BFP and consumption of industrialized foods I used a logistic regression controlling for age. Similar results were found using the logistic models below and Pearson's chi-square (Table 53). Using the logistic regression controlling for BFP participation, results suggest that age may be associated with higher frequency in consumption of food items of groups 2 and 3 combined, compared to groups 0 and 1 (Table 55). The effect of BFP participation or age was also not significant in any of the other models tested. All models are explained below.

The models below test address the effect of participation in the BFP (hypotheses 1.1, 1.2, and 1.3) and age (hypotheses 3.1, 3.2, and 3.3) on the frequency of industrially processed foods in women's diets.

Model testing hypotheses 1.1 and 3.1:

*Predicted logit of (FOOD PROCESSING LEVEL: Group 1, 2, 3 and Group 0) = 0.0238 + (0.2984)*BPF + (-0.0030)*AGE*

According to the model above, the log of odds of a woman consuming more foods from groups 1, 2 and 3 was positively related to participating in the BFP at the 5% level (p = 0.055), but not significantly negatively associated to age (p = 0.63).

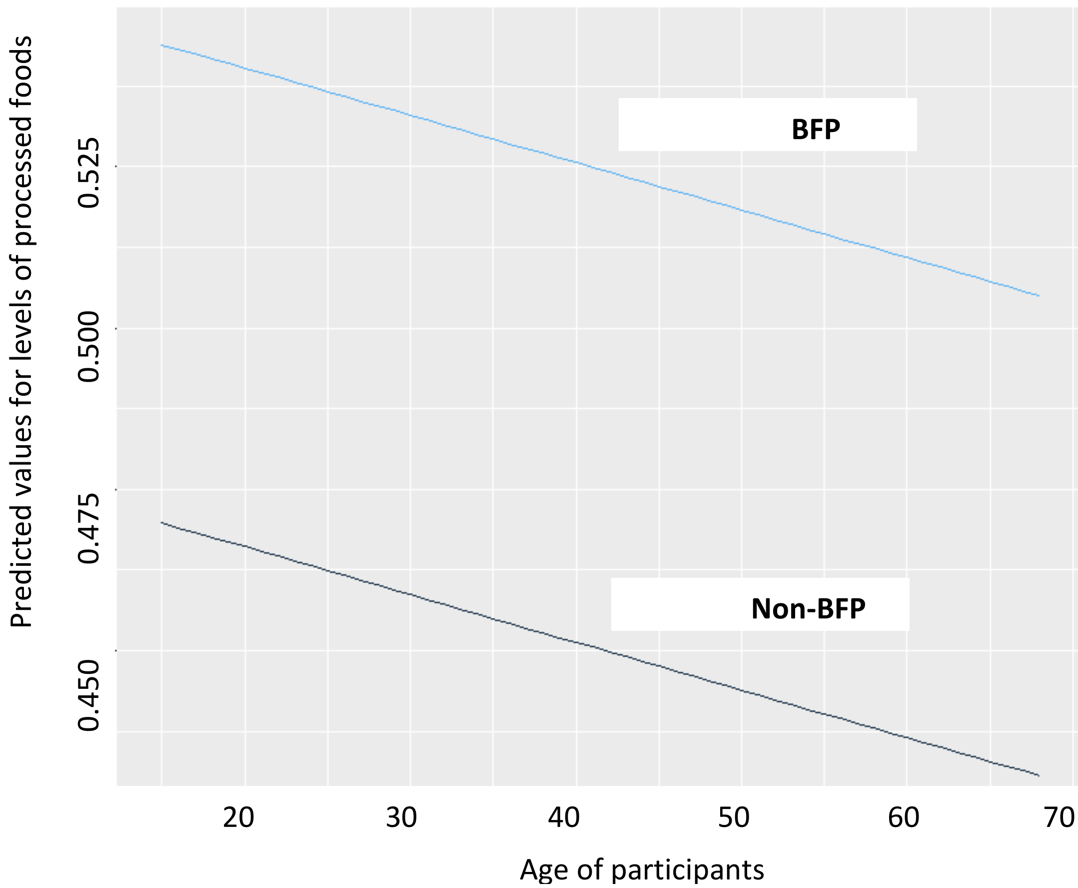


Figure 61. Probability of consuming processed versus non-processed foods by age for Bolsa Família and non-Bolsa Família participants

In other words, given the same age, women participating in the BFP were consuming processed foods from groups 1, 2, and 3 more frequently than women who did not participate in the program. Figure 61 shows the predicted probability of consuming processed foods for groups 1, 2 and 3 by age of BFP participants and non-participants, based on the model above. Hypothesis 3.1, was not confirmed, given that the effect of age was not statistically significant (Table 54).To test for the presence of correlation among dependent variables, which could mislead the interpretation of results, the variance inflation factor (VIF) was calculated using the Companion to Applied Regression package in R (Fox et al. 2016). The proportion that the variable BFP participation and Age share in the model was equal to 1.225, close to the value 1 of non-correlation (values above 5 signal a necessity for exclusion due to multi-collinearity), and therefore the variables remained in the model, as they both assisted in the explanation.

Table 54. Logistic Regression Analysis of food items in 43 dietary recalls of women participants and non-participants in the Bolsa Família Program by Age.

Predictor (Group 0 vs. Groups 1,2,3)	**β**	**SE β**	***p***	**e^{β} (odds ratio)**
Constant	0.0238	0.2009	0.9056	NA
BFP participation	0.2984	0.1558	0.0555 .	1.3477
Age	-0.0029	0.0062	0.6350	0.9970

p statistics: ***p<0.001, **p<0.01, *p<0.05, . p<0.1

The following two models, consider the effect of participating in the BFP on frequency of consumption of ultra-processed foods alone (group 3), or ultra-processed foods combined with food industry ingredients (group 3 and group 2). For these two models, participation in the BFP was not significant in predicting the probability of processed food items in dietary recalls at the 5% level or below, and age of women seemed to play a more important role.

Model testing hypotheses 1.2 and 3.2:

*Predicted logit of (FOOD PROCESSING LEVEL: Group 0, 1 and Group 2, 3) = -0.7724 + (0.3105)*BPF + (-0.0147)*AGE.*

The BFP participation predictor in this case was not significant (p=0.09), but controlling for it, results again suggest an association with age (p=0.06). In other words, controlling for participation in the BFP, older women might be consuming foods from Groups 2 and 3 less frequently than younger women (Table 55), which was expected as stated in hypothesis 3.2.

The variance inflation factor for this model was equal to 1.33 and therefore no multi-collinearity was detected.

Table 55. Logistic Regression Analysis of food items in 43 dietary recalls of women participants and non-participants in the Bolsa Família Program by age.

Predictor (Group 0,1 vs. 2,3)	**β**	**SE β**	***p***	**e^{β} (odds ratio)**
Constant	-0.7724	0.2369	0.0011***	NA
BFP participation	0.3105	0.1873	0.0974 .	1.3641
Age	-0.0147	0.0078	0.0594 .	0.9854

p statistics: ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Model testing hypotheses 1.3 and 3.3:

*Predicted logit of (FOOD PROCESSING LEVEL: Group 0,1,2 and Group 3) = -1.9727 + (0.4903)*BPF + (-0.0275)*AGE.*

The strength of evidence of the predictors for consumption of Group 0,1,2 versus Group 3 is low and the p- value for BFP participation and age was not significant (Table 56). The detection of an effect of age may have been compromised by the small sample size.

The variance inflation factor for the model above was equal 1.55 and therefore no multi-collinearity was detected.

Table 56. Logistic Regression Analysis of food items in 43 dietary recalls of women participants and non-participants in the Bolsa Família Program by Age

Predictor (Group 0,1,2 vs. Group 3)	**β**	**SE β**	***p***	**e^{β} (odds ratio)**
Constant	-1.9727	0.4176	0.0000***	NA
BFP participation	0.4903	0.3466	0.1572	1.6327
Age	-0.0275	0.0152	0.0712 .	0.9729

*p statistics: ***p<0.001, **p<0.01, *p<0.05, . p<0.1*

BOLSA FAMÍLIA: REPLACEMENT OF FOOD ITEMS IN DIETS

Logistic regressions with management of the BFP and age as co-variates were used to examine the relationship between participation in the BFP and consumption of particular food items in diets (question 2), which would signal a change in the meal structure, such as a replacement of a staple, or snack items. Hypotheses 2.1 and 2.2 were tested by accounting for the frequency of consumption of a food item during 24-hours, as recorded in dietary recalls conducted with women. For hypothesis 2.1, the items considered were rice, crackers, and breads. Chicken and beef products were not included because consumption was minimal (Table 59). These items were only counted if they had been purchased. Therefore, if foods were provided by another household as a gift or exchange, or at the school, they were not counted. On the same token, for hypothesis 2.2, only foods sourced locally and by a household member were accounted for in the analysis.

Hypothesis 2.1 posits that:

Women living in households participating in the BFP will consume purchased rice, crackers, breads (French bread and sweet bread), chicken and beef more frequently than women living in households which are not part of the program (controlling for age).

The assumption behind hypothesis 2.1 is that purchased rice, as an energy rich food, would be replacing local staples during important meals, such as lunch and dinner. Among the adult women in the sample, nobody consumed rice porridge, which, in this case, would be usually a snack taken between main meals. All instances in which rice was consumed were either during lunch (50%) or dinner (50%), except once served as a snack at the community school.

On the contrary, for crackers and breads, the assumption is they would be substituting energy rich unprocessed or locally processed foods usually consumed as snacks. For the sample considered, women were consuming crackers and breads either during breakfast (42.8%), or during in-between meals' snacks (14.3% of times in the morning, 39.3% in the afternoon, and once, 3.6%, at night).

Finally, animal protein was highly valued during main meals. Lunch or dinner without fish, game, chicken, or beef, the latter usually consumed in the form of sausages and canned, were not considered adequate. Consumption of purchased animal food was uncommon, at least during days considered typical by participants. Only appearing in 6 instances, 4 times for dinner, and 2 times for lunch in the sample considered. Commonly, not having animal protein during a meal would be equivalent to not having food. In a few households, there was a constant worry or fear of not having these items available.

For instance, in one of the household I stayed, where an elderly lady, Vania, lived with her granddaughter, Sandra, this was a constant everyday question. Vania's strenuous life story partially explains this worry. Vania got married at 15, and started working in the manioc fields then. Her husband worked rubber tapping, travelling to distant places for long periods. She had 9 children, and 3 died at young ages. Vania told me about many instances in which she was left alone with her children for months, depending on manioc they planted, and often on cured sausage, which she despised and would refuse to eat nowadays. She would always bring up memories whenever anyone mentioned sausage or ate it around her.

Many of Vania's relatives and friends would come by her house daily to check if she had any animal protein for the day. However, even when, from my point of view, there was an abundance of fish available, Vania would always voice a fear of not having enough food in the near future, expressed with daily questions such as: "how are we going to do for food tomorrow? Will we have any fish?"

Overall, results from this sample show no evidence of associations between participating in the BFP and shifts in the structure of diets, given that there was no significant evidence of substitution of core items. The frequency in consumption of purchased rice, breads, and crackers was not significantly different between BFP-participants and non-participants, controlling for age (Table 61). However, the higher frequency in consumption of crackers by BFP participants (more than double - Table 57), compared to non-participants, suggests this item may be replacing locally sourced snacks. Results from hypothesis 2.2 below give some insight for the interpretation of this finding. *Hypothesis 2.2* poses that:

Women living in households participating in the BFP will consume locally sourced foods such as fruit, manioc products (farinha, boiled and fried manioc, manioc sauce, manioc starch bread and flour, and manioc starch cookie), fish and game less frequently than women living in households which are not part of the program (controlling for age).

Farinha is an interesting case because it is an ambivalent food item in the structure of meals. While it is widely part of lunch and dinner meals, it is also consumed accompanying snacks (for example, with açaí or buriti fruit pulps), as well as during breakfast (for example, with fried bananas). Among adult women, 87.6% of the time, farinha was present in lunch or dinner meals, and 12.4% accompanying breakfast or snack foods. Controlling for age, the frequency in consumption of farinha was not different in the diets of BFP participants and non-participants, signaling no major changes, at least for this local staple (Table 62).

Manioc products were widely consumed as snacks and could potentially reflect a replacement of foods in diets, decreasing in frequency, along with the increase observed in the frequency of cracker consumption in BFP-participants' diets (hypothesis 2.2). There were 9 instances in which people consumed manioc products, excluding farinha, twice during lunch and once during dinner, the remaining consumed at breakfast or snack breaks. Fruits were consumed 57 times, approximately half the time during lunch or dinner, mostly cooked plantains or lemon for flavoring (47.7%), and the other half, including various fruits, during breakfast or snack breaks (52.6%).

There was no significant difference in the frequency of manioc products or fruit consumption between BFP-participants and non-BFP participants (Table 62). Therefore, the hypothesized substitution of unprocessed or locally processed foods by purchased ones during breakfast and snack breaks, as stated above, was not confirmed by the evidence presented here, at least considering an increase in the consumption of crackers along with a decrease in the consumption of locally sourced manioc products and fruits.

In terms of locally sourced animal protein, the frequency of game consumption detected was minimal (Table 60), perhaps because of the short period of data collection and seasonality effect in diet composition (Chapter 2). The frequency of fish consumption was high for both BFP-participants and non-BFP participants, and no significant difference was observed among these groups (Table 62). Therefore, there was no evidence of substitution for this local staple, reflecting results from hypothesis 2.1.

The results above seem incompatible. While results suggest that non-BFP participants are consuming unprocessed or locally processed foods (group 0) more frequently than BFP participants (Table 53,Figure 61), frequency in consumption of important foods in this group, such as farinha and fruit, exclusively produced by the household, are telling a different story. That is because, comparing BFP participants and non-participants, there was no difference in frequency of consumption of farinha, a staple in the region. Moreover, BFP-participants may be consuming fruits, produced by the household, more frequently than non-participants Table 58.

Although these relationships could be a function of age, given the small and unbalanced samples, the fact that age is not significant alone indicates otherwise. In any case, results are still inconclusive. One important characteristic of this unprocessed or locally processed group is that it excludes any recipes with the addition of industrially processed ingredients, for example any cooking involving vegetable oils or sugar as ingredients, even if the core item in the recipe is a local staple (e.g. fish stew).

Table 57. Frequency of specific carbohydrate rich food items purchased by participation in the BFP.

	Rice		**Crackers**		**Bread**	
	N	*%*	*N*	*%*	*N*	*%*
BFP participants	16	3.9%	14	3.4%	4	0.1%
Non-BFP participants	10	2.5%	6	1.5%	4	0.1%

Table 58. Frequency of specific energy rich food items produced by participation in the BFP.

	Farinha		**Manioc products**		**Fruit**	
	N	*%*	*N*	*%*	*N*	*%*
BFP participants	43	10.6%	47	11.6%	34	8.4%
Non-BFP participants	36	8.9%	38	9.3%	15	3.7%

Table 59. Frequency of specific protein rich food items purchased by participation in the BFP.

	Chicken		**Beef**	
	N	*%*	*N*	*%*
BFP participants	1	0.2%	2	0.5%
Non-BFP participants	1	0.2%	1	0.2%

Table 60. Frequency of specific protein rich food items produced by participation in the BFP.

	Fish		**Game**	
	N	*%*	*N*	*%*
BFP participants	25	6.2%	0	0.0%
Non-BFP participants	24	5.9%	1	0.2%

Table 61. Logistic regression results for specific purchased food items by BFP participation (controlling for age).

Predictor: food items	***β***	**SE *β***	***z***
Rice			
Constant	-3.67	0.68	<0.001 ***
BFP participation	0.50	0.47	0.28
Age	0.00	0.02	0.95
Crackers			
Constant	-3.34	0.89	<0.001 ***
BFP participation	1.37	0.77	0.08 .
Age	-0.04	0.03	0.22
Bread			
Constant	-3.9	1.46	<0.01 ***
BFP participation	0.72	1.14	0.52
Age	-0.05	0.05	0.31

z statistics: ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Table 62. Logistic regressions of group 0 food items and mode of attainment by age and participation in the BFP.

Predictor: food items	***β***	**SE *β***	**z**
Seasonings			
Constant	0.18	0.31	0.56
BFP participation	-0.33	0.26	0.2
Age	0.00	0.00	0.99
Manioc products			
Constant	-4.08	1.13	<0.001 ***
BFP participation	0.49	0.87	0.57
Age	0.00	0..4	0.88
Farinha			
Constant	-1.27	0.33	<0.001 ***
BFP participation	0.09	0.26	0.73
Age	0.00	0.01	0.98
Other			
Constant	-3.55	0.82	<0.001 ***
BFP participation	-0.05	0.58	0.93
Age	0.02	0.02	0.36
Fish			
Constant	-2.52	3.54	0.48
BFP participation	1.21	2.93	0.68
Age	-0.16	0.15	0.31
Fruit			

Constant	-2.01	0.43	<0.001 ***
BFP participation	0.49	0.32	0.13
Age	0.00	0.13	0.98
Predictor: mode of attainment	***β***	**SE *β***	***z***
Produced			
Constant	0.06	0.37	0.86
BFP participation	0.65	0.31	0.04 *
Age	0.00	0.11	0.93
Purchased			
Constant	-1.39	0.36	<0.001 ***
BFP participation	-0.14	0.29	0.63
Age	0.01	0.01	0.21
Received			
Constant	-1.05	0.93	0.20
BFP participation	-1.09	0.77	0.16
Age	0.04	0.03	0.21

p statistics: ***p<0.001, **p<0.01, *p<0.05, . p<0.1

A closer look into the unprocessed or locally processed group suggests there is no one food item accounting for the higher frequency in consumption of food items in this group by non-BFP participants. Again, this result may be a function of the small sample size or samples being unbalanced in terms of age range; for the sample considered, seasonings is the most plausible candidate accounting for differences. An interesting pattern arises when including the mode of attainment of unprocessed or locally processed foods: produced, purchased, or received from other households, with frequencies indicating differences between participants and non-participants in considering locally sourced foods and foods received from other households (Figure 62).

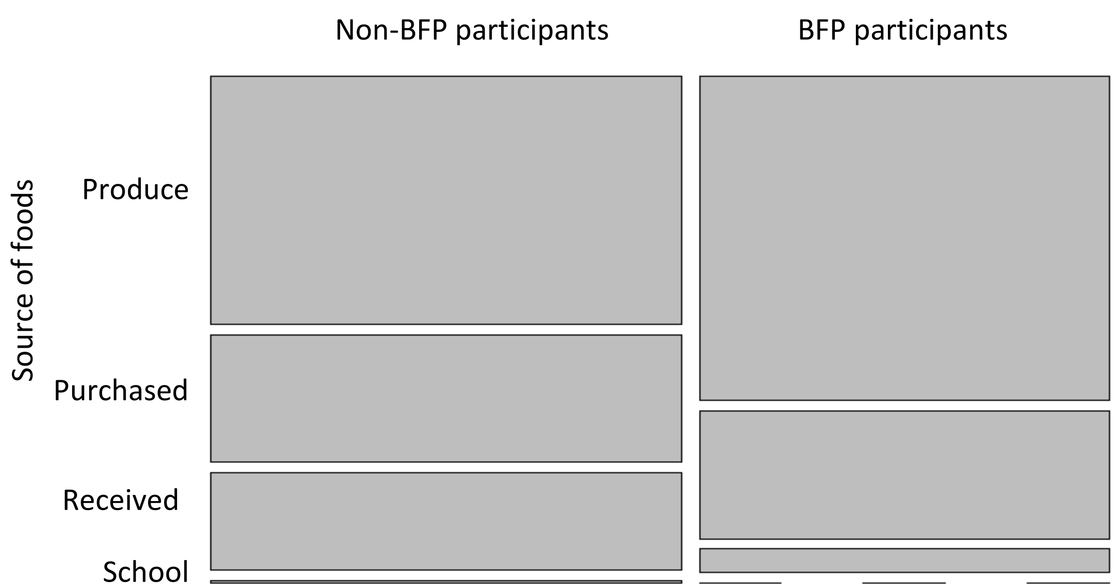


Figure 62. Frequency of source of foods consumed in women's diets by participation in the BFP.

Controlling for age, the frequency of consumption of food items produced by the household is significantly higher among BFP-participants than non-participants (Table 62). For foods received from other households, age alone significantly explains the differences observed and participation in the program does not seem to make a difference (Table 63). Surprisingly, there is no difference in the frequency of purchased items in diets of BFP participant and non-participant women.

Table 63. Logistic regressions of mode of attainment by age (excluding participation in the BFP).

Predictor: mode of attainment	β	SE β	z
Produced			
Constant	0.03	0.39	0.93
Age	0.01	0.01	0.36
Purchased			
Constant	-1.40	0.36	0.00***
Age	0.01	0.01	0.24
Received			
Constant	-0.83	0.88	0.35
Age	-0.06	0.03	0.03*

p statistics: ***p<0.001, **p<0.01, *p<0.05, . p<0.1

DISCUSSION

Here I bring an anthropological perspective to food consumption, considering food categories, instead of specific items out of context. This approach is instrumental for understanding changes in patterns of food consumption linked to shifts in diet structures. Results about the effects of BFP participation and age on diets of women living at Amanã are illustrated below (Figure 63), centered on the frequency of consumption of foods from unprocessed or locally processed (group 0) to ultra-processed foods (group 3), as well as modes of food attainment. Findings suggest an association between BFP participation with a lower frequency in consumption of unprocessed and locally processed foods (Table 54), conversely associated with a higher frequency in overall consumption of foods from all other processed food categories (groups 1,2, and 3, respectively locally prepared foods and purchased dry goods, food industry ingredients, and ultra-processed foods). Therefore, the effect of participating in the BFP can be detected at an early stage in terms of the extent of processing, apparently decreasing the frequency in consumption of foods which are unprocessed or are processed in the community, and not at an industrial level (e.g. seasoning or farinha).

Once you go a step up in the food processing range, including recipes that have their core ingredients as unprocessed or local foods, but require the addition of industrial ingredients in preparations (e.g. fish stews prepared with vegetable oil), the BFP effect is not significant, but results indicate that age play a more important role (Table 55). Age is also potentially having an effect when it comes to a higher frequency in consumption of ultra-processed foods (Table 56). These results indicate that young women may be experiencing the effects of a nutrition transition, as there is an indication of a possible shift towards a higher frequency in consumption of groups 2 and 3 foods (food industry ingredients and ultra-processed foods, without a BFP participation significant effect.

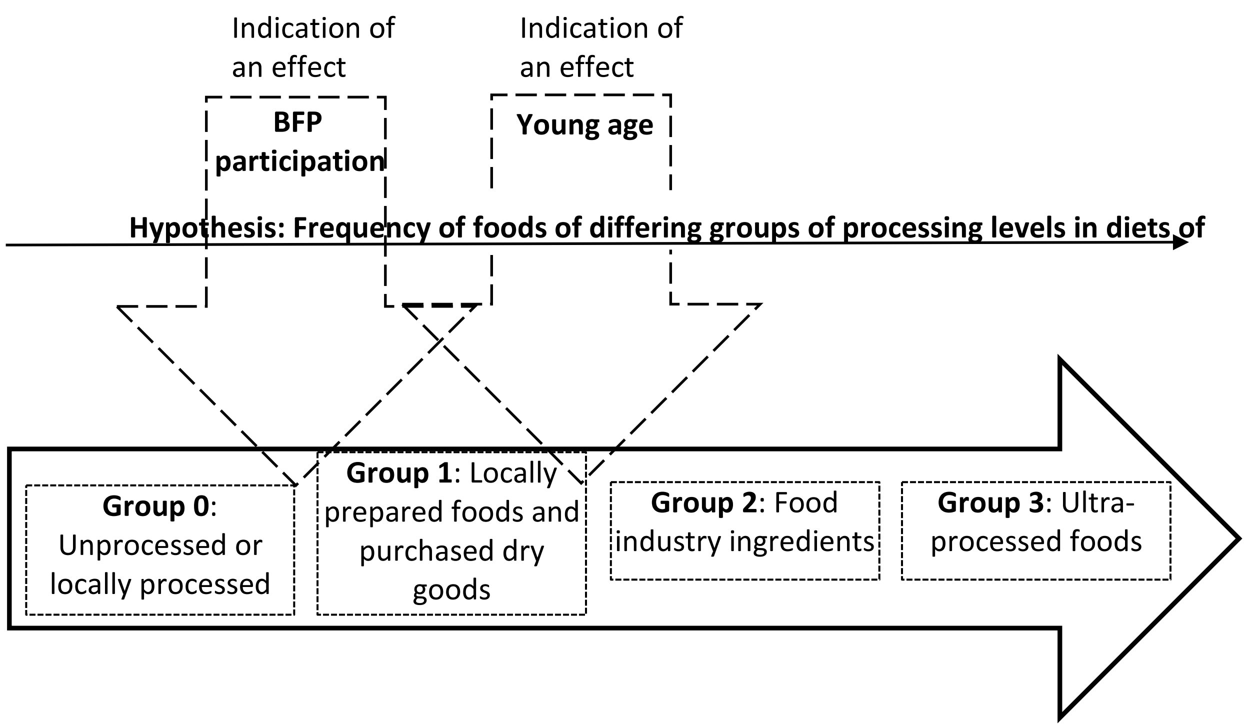


Figure 63. Scheme of the effects of BFP participation and age in consumption of processed foods by women at Amanã.

The question of substitution of staples is more complex than expected, at least for the context of Amanã. The higher frequency in consumption of unprocessed or locally processed foods (Table 54), group 0, was not confirmed by singling out the most important energy contributors of this group, farinha and fruits (Table 58). While there was no difference in frequency of farinha consumption between women in the BFP and non-participants, for BFP-participants' frequency of fruit consumption produced by the household is higher than for non-participants. In terms of protein contribution to diets, grilled meats are the only ones included in group 0 and are not frequent enough for this comparison to be relevant. Also, no evidence of protein source substitution was found when considering all groups of differing processing levels (Table 60). Results show that fish, prepared in various ways, is the most important protein source for both women participating and not participating in the BFP as well as from different ages.

A closer look into the unprocessed and locally processed foods group (group 0) shows no single item or group of items significantly accounting for the higher frequency in the diets of non-BFP participating women. By descriptively comparing the frequency of consumption for each food included in group 0, numbers suggest this difference are accounted for mostly by an increase in the use of seasonings, although when singled out the difference was not statistically significant (higher frequency among non-participants' diets 54.5% compared to 46.7% of all group 0 foods for participants) . One possible explanation for the effect of the BFP on group 0 is that seasonings might be assuming a more important role in creating a less monotonous diets for non-BFP participant women at Amanã. A diverse array of these plants in different combinations may increase the desirability of consuming staples (e.g. fish stew with many seasonings –e.g. Figure 58), especially if there is a limitation to adding variety through purchased foods. Additionally, plants used as seasonings are usually coming from high raised beds, protected from floods, and these are predominantly under the domain of women in the household. These home gardens have been described as embodying meanings beyond aesthetics or economic strategies for women in the rural Amazon, attached to emotions and memories of experiences (Murrieta and WinklerPrins 2003).

The results discussed above do indicate that the composition of diets of women living at Amanã show little evidence for the shifts in diet structure proposed in the literature for rural populations, including in other areas of the Amazon. This study supports that the isolated effect of BFP participation is not responsible for dietary shifts, and that age may be an important factor mediating these changes. In Chapter 5, age and management of the BFP benefit are discussed in detail, and these associations are further uncovered.

The one exception, in terms of BFP-participation, is an indication of increased frequency of consumption of crackers among participating women (Table 61). Evidence from this chapter and chapter 5 shows that crackers and breads may be important elements of substitution in overall diets of Amanã residents. There were a few accounts of crackers used as a substitute for manioc flour in some cases. For instance, a young woman was famous in one of the communities for her preference of drinking açaí with crackers, instead of with the commonly appreciated addition of manioc flour. That was a clear substitution, but one that most people found strange. Ethnographic information was collected only among BFP-participants and crackers were commonly eaten at breakfast or between meals as a snack, justified by some women by the absence of products such as bananas, yams, sweet manioc and *beiju*. The most frequent group 4 food consumed was crackers, the only single item in this group representing more than 2% in frequency of consumption, considering all items in diets.

It is important to note that the effect of the BFP on a higher frequency of consumption of food industry ingredients and ultra-processed foods was significant at the 10% level (Table 55), and given the small sample size, it is possible that the difference was simply not detected. Similarly, the effect of age was significant at the 7% level considering only ultra-processed foods (Table 56). To elucidate these issues, the analysis of carbon isotopes from fingernails can shed light into how these substitutions play out if a higher sugar intake is associated with women participating in the program. Data on fingernail carbon isotopes has been collected, but not yet analyzed and interpreted.

The limitations of this study to detect changes in diets include the small sample size, data collection period (only during the dry season), age-range, unbalanced samples, as well as dietary recalls reduced to frequency of consumption as opposed to quantities. As shown in Chapter 2 seasonality affects food availability in the region and these patterns may fluctuate accordingly. In any case, at least for the dry season, results indicate that women residing in households receiving the BFP benefit are not consuming staples, such as fish and farinha, less frequently than non-participants; and that there is some indication that BFP-participants are consuming fruits more frequently, produced by household members.

It is intriguing that, controlling for age, BFP-participants do seem to be consuming locally produced foods more frequently than non-participants. Possible explanations, are that BFP-participants purchase foods which were classified as belonging to the unprocessed group (group 0), such as fruits and vegetables not produced by the household, for example oranges and tomatoes. Further analysis is required in order to elucidate these differences, keeping in mind that age may be a mediating factor in all these associations. Moreover, another pattern observed was an association between age and foods received from other households. The households providing unprocessed or locally processed foods are potentially the ones with older women who do participate in the BFP, given that the majority of households in the communities studied are part of the program.

These food "donations" or exchanges of foods between households were common and were referred to by the verb *vizinhar* (literally translated as "to be neighbors"). In the section entitled "Bolsa Família: replacement of food items in diets" I presented Vania's story, a household with an elderly lady and her granddaughter who constantly received foods from relatives and neighbors. Results fit in with the notion that newly formed households may be perceived by other households in the community as more vulnerable or food insecure, so the frequency of food donations to them is higher, especially when relatives reside in the same community or nearby, which in Amanã is almost always the case for at least one household member.

In sum, as predicted in the nutrition transition model, there is some indication of an increased reliance on industrially processed foods and possibly a substitution for unprocessed or locally processed foods linked to young age. However, results are inconclusive given the limitations in the analysis presented previously. On the other hand, there is significant indication that participation in the BFP at Amanã is not linked to a substitution for local staples in diets. In fact, BFP participation alone is not linked to a decrease in consumption of foods produced by the household, and there are significant results indicating the opposite effect. This is contrary to results found in a pioneer study conducted in rural communities in the eastern Amazon (Piperata, Ivanova, et al. 2011; Piperata, McSweeney, and Murrieta 2016). These substitutions of staples at the expense of food production, observed in the literature connected to income increase from cash crops (Ulijaszek 1993; Baker and Friel 2014) or from cash transfer programs (Piperata, McSweeney, and Murrieta 2016) do not seem to occur at Amanã.

Piperata, Ivanova, et al. (2011) conducted a study looking at the effects of the BFP and other social benefits on dietary shifts of ribeirinhos in the eastern Brazilian Amazon, specifically at the Caxiuanã National Forest. This is the study that is most comparable to this one, as it looks at specific food items. Work by Piperata, McSweeney, and Murrieta (2016) focuses on anthropometric data and dietary adequacy (macronutrient intake, as analysed in chapter 2) coupled with ethnography and is discussed in more detail in chapters 5 and in the conclusion of this dissertation. For both studies mentioned above there are some key contextual differences explored further at the end of this section. The research conducted in the eastern Amazon has a different design for evaluating the effects of the BFP on women's dietary intake. Instead of using a control group, as is the case here, they collected data before, between 2002 and 2003, and after the implementation of the program, in 2009, with the same population. Also, they collected detailed 24-hour recall data for both points in time, and were able to evaluate macronutrient intake from various food items, finding a decrease in energy intake, and no significant change in protein and fat.

Similar to results from this study, manioc producs, including farinha, remained the most important source of carbohydrates in the diets of women in Caxiuanã. However, results from Piperata, Ivanova, et al. (2011) indicate that purchased beans, rice, and crackers were substituting locally sourced foods, especifically açaí, fish, and fruit, previously accounting for a higher percentage of kilocalories in diets. Moreover, they observed a clear decline in manioc gardens linked to an increased reliance on purchased foods, but cash income, including from the BFP, was not significantly associated with dietary intakes in 2009.

One of Piperata, Ivanova, et al. (2011) key arguments is that increased access to cash lead to the abandonment of manioc fields. This altered the relatinship of households with the market, historically involving a mixed subsistence strategy of food cultivation, extractivist activities and wage labor. Women's diets reflected this change by showing a substitution of local staples and a decline in overall kilocalorie intake. In 2009, they state: "purchased foods were replacing rather than complementing local foods" (Piperata, Ivanova, et al. 2011)

The argument formulated by Piperata, Ivanova, et al. (2011) seems not to hold true for Amanã. Comparing BFP-participants and non-participants residing at Amanã, there was no clear replacement of local staples and participants were in fact producing more of the foods consumed. In the context of Amanã it is fair to consider manioc and fish as resilient foods, demonstrating a dietary adaptive strategy, as suggested in Adams et al. (2012).

The comparison with Caxiuanã brings two important questions, the first regarding diets:

i. Why, at Amanã, there was no dramatic shift in diets, with a substitution of staples, as observed in Caxiuanã?

The second question is about the link with productive activities:

ii. Why, at Amanã, there was not a clear decrease in maintaining manioc fields?

Once these results are considered under this dissertation framework (Figure 53), some contextual factors become apparent.

In terms of historical and environmental contexts, the National Forest of Caxiuanã is a good comparison case to the Amanã Reserve, given that it is located in an upland forest region, are conservation management unit established under the Brazilian system of protected areas, and are distant from urban centers. However, some key differences are:

i. The strong presence of the açai as a cash crop in Caxiuanã (Piperata, Ivanova, et al. 2011). In Amanã farinha assumes the function of a cash crop when prices are high, but prices fluctuate greatly and this product is part of a regional market, differing from the açaí global economy (*farinha puba*, the most pervasive in terms of consumption and commercialization in the north region of Brazil, is nearly inexistent in southern regions of the country).

ii. Amanã communities were located on a white-water river system known for its fertile lands. Residents of Amanã are recognized by neighboring reserves as agriculturalists. On the contrary, Caxiuanã is located on a black water river system with potentially productivity, affecting people's livelihoods and commercial activities (Piperata, Ivanova, et al. 2011).

iii. In 2002, government services provided to Caxiuanã, in terms of education, health, and sanitation were described as very poor (Piperata 2007) and there was a lack or minor improvements in 2009 (Piperata, Ivanova, et al. 2011). Similarly, in 2013, most households did not have pit toilets in Amanã, but the communities held important assets: running water connected to a well; generator, which would commonly run for a few hours at night; elementary schools and a secondary school in the largest community studied, as well as a health center attended by local health agents.

The three points outlined above clearly reflect differences in the physical and social environments between Amanã and Caxiuanã. Other important factors need to be investigated. For instance, Amanã had an intense history of social organization linked to an environmentalist movement behind the creation of the Reserve (Queiroz 2011). These started with the inciting of the liberation theology by the Catholic Church, continued by the establishment and overseeing of the reserve by the Mamirauá Sustainable Development Institute. Additionally, household decisions and gender relations are also a crucial factor in understanding these trends in diet change and production. For instance, Piperata, Ivanova, et al. (2011) ethnographically describe men referring to the BFP benefit as their wife's money to be used for food purchase, with men potentially contributing less to food provisioning in the household. Men were described as engaging in binging, spending all the money earned from wage labor immediately in the nearest town of Portel (Piperata 2007). For Amanã, we see in Chapter 3 that in most households the BFP benefit was managed jointly, although women felt strongly about participating in decisions of expenditure. Moreover, at Amanã, a few men were in fact controlling expenditure of the BFP benefit seen with good eyes by women in the majority of the cases.

Studies investigating income rise give insights on the consequences of BFP participation to diet transitions, and they informed the arguments presented here. However, the nature of cash received from family transfer programs is unique, as it is not directly a result of labor mobilization (Lui 2014). Moreover, as outlined in Chapter 3, income from the BFP has differential effects in management, money usage, and in workload among household members. In Chapter 5, I further discuss these relationships, investigating the effects of different BFP benefit modes of management in the household, on diets and health status of women and adolescents living in Amanã.

CONCLUSIONS

The framing and categorizations used in research have been shown to have influenced its practical implications and contributions to disciplinary fields. Here, I use the nutritional anthropology conceptual model in an attempt to bring grounded evidence for the recommendations of future research interested in understanding dietary shifts linked to family cash transfer programs such as the BFP in Brazil, particularly for the rural poor.

Results from this study corroborate with an idea that the BFP is associated with a change in diets of women living in the Amanã Reserve in nuanced ways. This change is characterized by a complementation of diets, increasing the amounts of food items which are added to recipes and have local staples as a core item, such as fried bananas and porridges. In diets of women at Amanã there was a minor evidence of a shift in the structure of diets linked to participation in the BFP, and no replacement of local staples, as predicted by the nutrition transition model. This result is contrary to research evidence from other areas, showing a dietary shift liked to income increase from cash crops (e.g. Ulijaszek 1993; Finnis 2009), and more pertinently linked to the BFP itself in the Eastern Brazilian Amazon (Piperata, Ivanova, et al. 2011).

Previous studies looking at nutrition transition trends and income raise in rural populations have stressed the importance of maintaining food production as a means to food security, both in terms of providing enough food and adequate nutrition to household members. One crucial difference observed at Amanã is that participation in the BFP was not associated with abandonment of production for food provisioning, in fact, women participating in the BFP were consuming local staples, fish and farinha, with the same frequency of non-participants, but were consuming foods produced by the household more frequently, including bananas, açaí, watermelon and mangoes.

Younger households relied on the common practice of food donations more than older households and there was some indication that age may be linked to a shift in the structure of diets, as proposed in the nutrition transition model. Results suggest that younger women may be consuming industrially processed foods more frequently, including ready to eat foods such as breads and crackers, as well as ingredients such as sugar and dairy powder. Therefore, there are signs of a nutrition transition happening in the diets of women residing in Amanã, but the evidence shows that the role of the BFP is more complex than a simple matter of participation or not.

As outlined in all chapters, particularly detailed in the introduction of this dissertation, many factors are important in understanding the links between participation in the BFP and dietary shifts. Household income and decision making are key variables, intrinsically related to these diet and health changes at the local level. At a broader level, considering the BFP consequences to health and nutrition, it is important to stress the vulnerable socioeconomic conditions in which these populations are living, overall marked by a lack of access to infrastructure and social services. These issues are further explored in the next chapter looking at the effects of the BFP on nutrition and physical status of women and adolescents in Amanã.

CHAPTER 5: BFP CONSEQUENCES TO PHYSICAL STATUS AND NUTRITION

THE STORY OF FABIANE

Fabiane is the daughter of a Silene and Antônio. Her family moved to Santo Agostinho towards the end of my fieldwork. As soon as Fabiane arrived, she was eager to become part of the community and was excited about participating in all activities of my research – all the other 13-year-olds like her were participating. She had no problem making friends in the community right away. She is lively, spontaneous, and witty, and she soon became one of the most popular kids around.

Fabiane's family, however, was one of the most dysfunctional in the community. Antônio suffered from severe alcoholism and Silene had psychological problems, which were well-known in the community. At first, she and her siblings were living with her grandparents, and when school finished they moved out to a house built for teachers, who would often come from town or other communities to teach, staying there for extended periods of time. They started building a house, and despite the disbelief that they would eventually move there, they did. This was despite the fact that it had no more than one standing wall, as I witnessed during my last month there.

Fabiane is the oldest one of her siblings, and had one younger sister, Leila, and one younger brother, Gudu. Leila turned 11 years old while I was there. She worked cleaning the house of João, an elderly man, as well as doing other menial jobs in some other households. Women from the community houses commonly asked around for her whenever they needed extra help in their homes. They used a nickname for Leila that I eventually found out she disliked. Once Leila told me that, I made the effort of always calling her by her first name, even though people in the community would not know who I was referring to whenever I mentioned her actual name.

During the photovoice activity, Fabiane participated actively and produced two narratives coupled with photographs she herself took. I asked adolescents to report on their routines, and Fabiane prepared two pieces. The first, Figure 64, was about her work as a nanny for another household in the community, Eliel and Gera's, who had four children, the eldest a seven-year-old boy. Gera was a teacher in another community and was rarely around; Eliel worked mostly in the manioc fields and fished. The second narrative by Fabiane was about how grateful she was that her neighbor, Maria, had a *cacimba* and let her use it (Figure 65). Fabiane could go get water there during the dry season. Fabiane's house was the furthest away from the river and from any flooded areas surrounding the community, used for bathing, washing dishes and clothes, and processing food. Since Fabiane's house was the last one built there, it still lacked a pipe connected to the community well.

"I come to work at 6:30 AM. I just wash dishes, clothes and clean the house. Sometimes I make lunch. I enjoy doing all of that. I think it's important to work because I learn. This way, when I have my family, I already know how to do everything. I take care of this baby in the photo. I put her to sleep, bath her, and change her dippers. If my mom could have a baby, I would like it, but she can't because she had an operation, and she says they [babies} serve just for bringing worries. I don't think the same way, after all, I take care of this baby" (Fabiane's narrative for "My work as a nanny" photovoice)

Figure 64. Fabiane’s photovoice: “My work as a nanny.”

“In our community we have three streams. They are good for taking a bath, washing clothes, doing dishes, etc. During the dry season, some houses end up very far from the water, especially mine, which is the last of the community. The relief is that my neighbor has a water pit that is very close to my house. So I have a lot to thank God and my neighbor.” (Fabiane’s narrative for “The streams” photovoice)

Figure 65. Fabiane’s photovoice: “The streams.”

In Fabiane's first piece, "My work as a nanny" (Figure 64), she describes how she is learning important skills that will be handy when she has a family of her own. At 6:30 in the morning she starts taking care of Eliel and Gera's baby. She also cleaned the house and sometimes prepared lunch before leaving for school in the afternoon. Fabiane and Leila were the only kids in the community who were actually working for other families, and Silene and Antônio were getting paid for their work. However, many of the girls her age did similar jobs at home, or in the home of relatives, commonly taking care of children and doing household work.

In the upcoming pages, I briefly lay out the theoretical background and discuss the effects of the management of the Bolsa Família benefit within the household, on the health of mothers, girls, and boys residing in Amanã. I present results from anthropometric data, interpreting them in light of findings from chapters 2 and 3. For adolescents living at Amanã, such as Fabiane, increased BMI is associated with the BFP benefit managed by the mother in the household. Considering the context of daily activities and aspirations presented by Fabiane in her photovoice, as well as a common pattern of early pregnancy and limited opportunity for professional development, I argue that there is an imminent detrimental effect on the health of adolescent girls living at Amanã.

INTRODUCTION

This chapter addresses some of the consequences of the Bolsa Família Program (BFP) on the nutritional status of mothers and adolescents in Amanã. The analysis compares the nutritional status of mothers and adolescents living in households where mothers have control over the management of the BFP benefit, compared to where the BFP benefit is jointly managed. From Chapter 3, I introduce elements of theories related to money management and women's empowerment at the household level, precursors to the development of family cash transfer policies (Hoddinott and Bassett 2008). I also dialog with theories of nutrition transition, especially dimensions related to income and gender.

The nutrition transition is identified as a shift in the structure of diets observed in various regions of the world, characterized by an increased reliance upon processed foods and consumption of cheap vegetable oils (Popkin, Adair, and Ng 2012). As argued in Chapter 4, the nutrition transition predicts a substitution of unprocessed or minimally processed food items for cheaper, more energy-dense ones. Beyond changes to diets, the nutrition transition also postulates a "pandemic of obesity," although no causal confirmation of the direct link between obesity and diseases has been confirmed (Guthman 2011). Many researchers have recognized the pitfalls of using BMI as a sole indicator of health status, and arbitrary cutoffs may have harmful consequences for various populations (e.g. Guthman 2011; Nestle and Nesheim 2012)). Nevertheless, association between obesity and various diseases such as coronary artery disease, and endometrial, breast and colon cancer have been widely reported, and rates of obesity are increasing worldwide (NIH 2013). This rise in obesity rates started among the wealthy in developed countries during the 1980s, and at the time it was unthinkable that similar patterns would affect the poor in developing countries (Popkin 2007). The 2008-2009 Brazilian census, however, shows that 25% of adults older than 20 years of age are considered obese, 16.9% of women and 12.4% of men; an increase of 47.3% for women and more than a fourfold increase for men (2.8% were obese in 1974), since the mid-70s (IBGE 2010).

These changes have been extensively documented at global and national levels (Popkin 2004; Monteiro, Conde, and Popkin 2007; Drewnowski and Popkin 2009), but its mechanisms and nuances at the local level are still poorly understood. Shifts in diet structure and physical activities consist of complex processes, and involves multiple variables, with differential consequences. There is no doubt that the pace of the obesity rise is alarming in Latin America. However, the connections between diet change and health status among different populations, are still unclear, and using the nutrition transition as a model of progressive stages limits our understanding of its processes (Pelto, Dufour, and Goodman 2012).

For instance, socioeconomic status (SES) and income rise certainly have an effect on nutrition transition processes (Monteiro, Conde, and Popkin 2007; Wells et al. 2012). In an attempt to debunk common “big fat myths,” (Brewis 2012) argues that socioeconomic patterns have shown overwhelming evidence for a rise in obesity, in contrast to the insufficient explanations for a genetic basis. Using IBGE longitudinal country level data on obesity, (Monteiro, Conde, and Popkin 2007) argues that the increase in obesity, at least from the late 1980s through the early 2000s, was mostly restricted to women in the lowest SES, compared to women of all other SES (Table 64, Figure 66). When SES is not considered, the overall rate of increase in obesity among women in Brazil show misleading numbers. For instance, from 1989 to 2003, the change in obesity prevalence rates for all women varied from 12.4 to 13%, whereas, controlling for SES, women in the lowest income bracket showed an increase from 8.9 to 11.2%. The disparity in change of obesity prevalence change between low and high SES was even greater considering the 1975 to 1989 period.

Table 64. Changes over time in obesity prevalence rates among Brazilian women, by income.

	Obesity Prevalence Rate, %			Age-Adjusted Prevalence Ratio (95% CI)	
Family Income Quintile	1975	1989	2003	1975–1989	1989–2003[a]
First (lowest)	2.6	8.9	11.2	3.27* (2.64, 4.06)	1.36* (1.14, 1.62)
Second	5.7	11.7	13.5	1.97 (1.65, 2.34)	1.17 (0.99, 1.39)
Third	8.8	14.8	13.5	1.65 (1.40, 1.94)	0.87 (0.73, 1.03)
Fourth	11.0	14.3	14.1	1.30 (1.10, 1.52)	0.92 (0.77, 1.10)
Fifth (highest)	8.6	12.7	11.5	1.42 (1.23, 1.65)	0.90 (0.76, 1.07)
Total	7.4	12.4	13.0	1.63 (1.47, 1.80)	1.03 (0.95, 1.12)

Reproduced from (Monteiro, Conde, and Popkin 2007).

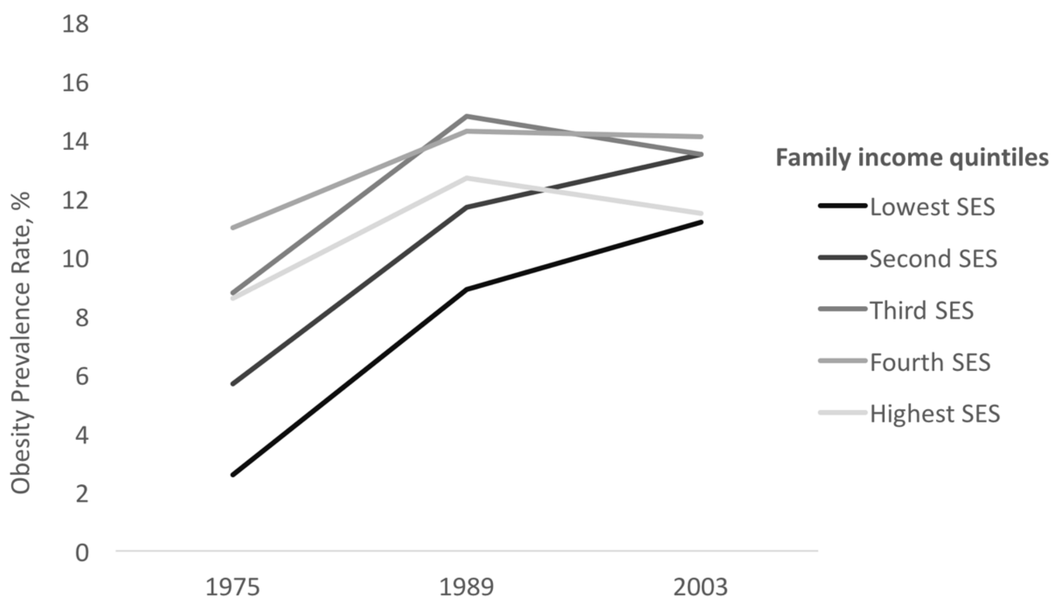


Figure 66. Changes over time in obesity prevalence rates among women, by income level in Brazil. Adapted from (Monteiro, Conde, and Popkin 2007).

In the context outlined above, (Drewnowski and Popkin 2009)pose an imperative question for policy and international agencies: "How best to promote economic growth *and* prevent or delay the undesirable health effects of a nutrition transition?" Hence, are conditional cash transfers, such as the BFP, part of the answer? Or are they part of the problem? For whom, and under which circumstances?

The questions outlined above illustrate how fundamental the contextualization of worldwide trends are in understanding the effect of policies at the local level. Identifying the mechanisms of a possible substitution of locally sourced foods for industrially processed ones, linked to a rise in overweight and obesity, is key for evaluating cash transfer program aimed at improving the lives of low income populations. From a national point of view, the BFP may be improving school attendance by children and youth, and the use of preventive health care by pregnant women and children (Fiszbein et al. 2009), as well as empowering women in the household (Rego and Pinzani 2014). However, unintended consequences are likely. For instance, as in the case of the rural Amazon, the program may well have detrimental effects on livelihoods and health (Piperata, McSweeney, and Murrieta 2016).

Several researchers have pointed out the invisibility of Amazonian populations, especially residents of mixed descent, usually referred to as *caboclos* or *ribeirinhos* (Nugent 1993; Adams, Murrieta, and Neves 2006; Brondízio 2008). The few studies assessing their health status, including this study, showed high rates of chronic malnutrition in children and youth at present, despite improvements at the national level. Adults also show signs of chronic malnutrition, and recent studies have also uncovered a rise in obesity with links to the nutrition transition (Adams 2002; Piperata 2007; Alencar et al. 2008; Piperata, Spence, et al. 2011; Silva et al. 2010).

The patterns outlined above have been described in the literature as the “double burden hypothesis”: either occurring at the same time, as seen in children who are both stunted and overweight, or throughout a person's lifetime, with early malnutrition and, later, adiposity in adults (Benefice et al. 2007; Susan Tanner et al. 2014). Similarly, prior chronic undernutrition has been associated with low body mass in adolescents (WHO 1995). One possible explanation entails that when people were exposed to food shortage periods in early growth stages, they later evolve to compensate for it by overeating, in environments where food scarcity is absent (Gluckman and Hanson 2005); and effects may be exacerbated in the presence of obesogenic environments (Jehn and Brewis 2009).

Factors such as urbanization, market integration, cash availability, and environmental contamination have been linked to the nutrition transition effects in Amazonian populations (Godoy et al. 2005; Blackwell et al. 2009; Nardoto et al. 2011; Anticona and San Sebastian 2014), but few studies have delved into any specific mechanisms of change. The unique study by Piperata et al. (2011) at Caxiuanã shows a clear link with abandonment of manioc fields and cash availability through social benefits. Many researches are recognizing the importance of studies that build upon an understanding of social and biological dimensions of health in the region. For instance, studies that include the analysis of household variables (Piperata, Ivanova, et al. 2011; Silva et al. 2016) and taste preferences (Lima 2010), as well as physical activities patterns (Dufour and Piperata 2008), and disease burden settings (Silva 2009; Tanner et al. 2009).

If even the residents of remote areas of the Brazilian Amazon are experiencing the effects of this double burden to their health and development, then it is crucial to understand the specific mechanisms through which these changes are becoming possible, and detrimental to these already historically marginalized populations. In Latin America, the relative annual increase in percentage of obesity among women living in rural areas is higher compared to urban, almost doubly so: 4.6% and 2.5% respectively (B M Popkin, Adair, and Ng 2012). Raising income by directing cash transfers to women in the household in rural areas has a potential to change the dynamics of household decision making, not always affecting livelihoods in the intended fashion.

As discussed in Chapter 3, the BFP benefit is preferably transferred to mothers. Decree 5209 regulates the law which created the BFP in January 2004, stating that “the primary holder of the BFP benefit will be preferably the woman, as she should, when possible, be previously selected as the person responsible for the household unit at the time of registration” (writing reviewed by decree 7013 in 2009). The law was created based on an assumption that mother’s control over the benefit inside the household would increase food availability, leading to a better health status for children in the household (Thomas 1990; Behrman 1997).

In the case of regions in the rural Brazilian Amazon, policies such as the BFP have significantly altered families’ incomes (Lima 2010; Piperata, Spence, et al. 2011). However, in the context of the Middle Solimões, more specifically in Amanã, where this research was conducted, changes in productive activities are not as apparent: most residents have livelihoods based on mixed productive activities that are mostly subsistence based, combined with commercialization of a few crops or other resources (e.g. fisheries, NTFPs, and basketry).

By bringing data from previous chapters, here I address one of the main research questions from the general conceptual framework detailed in the introduction of this dissertation. I address the consequences of the BFP on the health status of the population living in Amanã, keeping in mind the complex context in which these associations are embedded. The key data used in this chapter is anthropometric, which is introduced as a proxy for measuring health status and nutrition of women and adolescents living in Amanã.

The goal of the research question addressed in this chapter is to build on and expand the analyses presented previously, in order to understand the health effects of the BFP for rural residents of the Amanã Sustainable Reserve. Here, I explore correlations between income, management of the BFP benefit as a household financial decision, and health status and diets for adult women and adolescents living in Amanã.

Health status is operationalized using anthropometric variables, informed by the dietary data presented in detail in Chapter 2, modes of food attainment and levels of industrial food processing (Chapter 4). The specific objectives of this chapter are:

1. To present a picture of the health status of Amanã residents;
2. Analyze the relationship between income and BFP management in diets and health status; and
3. Contextualize these relationships from a social and cultural perspective, based on the literature and ethnographic data.

The following sections are organized by initially presenting the methods, with a focus on anthropometric data and an evaluation of the health status of adult women and adolescents. I then present the findings of models assessing the effects of income and modes of BFP management inside the household on dietary and anthropometric variables for both mothers and adolescents. Finally, the results are discussed in light of the ethnographic context and specific regional literature.

METHODS

As in Chapter 2, I used statistical models to investigate how much particular aspects of diets and health status can be explained by income and management of the BFP benefit (specific objective 2). The selection of co-variates was considered in terms of their relevance to the specific objective listed above, as well as in terms of avoiding multicollinearity, and contribution to the explanatory models (compared models based on AIC). The addition of random intercepts, as well as slopes varying across season is theoretically sound given that measures were repeated by individual and season, and there was variation in the rate of dietary and health variables change by season for each individual (non-parallel regressions), with the inclusion of random slopes producing models that fit the data to a greater degree than models exclusively with random intercepts.

The data and variables used in the analysis conducted in this chapter are summarized in Table 65. Income variables tested for models included total household income, percentage of total income accounted for the BFP, or income per capita; the latter accounting for household size, and therefore considered theoretically sound. Chapter 3 presents methods of data collection and analysis for classification of BFP benefit management and calculations of household income as exclusively considering governmental benefits and wages received by household members. This was due to data collection limitations, as well as based on the relative stability of these income sources, as well as literature on their importance for the domestic economy of rural Amazonian households. Chapter 3 also presents a qualitative analysis of interviews conducted with women about management of the BFP benefit, coding according to women's descriptions of decision making around the benefit's usage in the household. Based on the identified themes, BFP benefit management modes were classified in 3 main categories: joint (J), women's personal (WP), and men's personal (MP).

The methods used in for dietary data collection (chapters 2 and 4) have been presented previously. The complexity of dietary data is great and there are a number of possibilities for analysis, ranging from assessments of macronutrient intake, to dietary diversity, differing recipe preparations, food sources, and so on. Chapter 2 of this dissertation presents a detailed description and analysis of dietary data, particularly macronutrient intake, seasonal variability, and gender and age. Chapter 4 is also heavily based on dietary data, with a primary focus on differences between BFP recipients and non-recipients from the point of view of industrial food processing and food sources (locally produced, purchased or received from other households). Based on results from previous chapters, the following dietary variables are considered here:

- Kilocalorie intake, as indicators of dietary adequacy;
- Kilocalorie intake from manioc flour and fish, as indicators of the contribution of local main staples to overall diets; and
- Kilocalorie intake from fried bananas, vegetable oil added to dishes, and highly industrialized food intake, as indicators of the incorporation of industrially processed foods into household recipes (fried bananas and vegetable oil added to dishes), or as ready-to-eat foods into diets (highly industrialized foods group).

For the anthropometric data, height-for-age (HAZ) is used as an indicator of long term nutrition, and weight-for-height (WHZ), BMI, and sum of skinfolds (ZTSF+SSF) are used as indicators for short term nutrition and fat status. Despite the problems of using BMI as an indicator of weight status reported in the literature (as discussed in the Introduction), this index was used in many of the analysis presented here. This is because BMI values mirrored sum of skinfolds and arm fat index values for adult women and female adolescents (Figure 68, Figure 69), as well as given that BMI is most frequently used in the literature, allowing for comparison with other studies.

Table 65. Units of analysis and data summary

Unit of analysis	Income	BFP Money management	Dietary data [a]	Anthro-pometry [a]
Adult mothers	NA (36)	NA (31)	18	39
Female adolescents	NA(10)	NA (10)	10	12
Male adolescents	NA (15)	NA (13)	15	15
Household	43	34	NA	NA

[a] Average participants per season.

Data analysis about the effects of the management of the BFP benefit on dietary and anthropometric variables was conducted using generalized linear mixed models (LMM), again using the “lme4” package (Bates et al. 2015). As detailed in chapter 2, these models are appropriate when dealing with nested structures from measurements nested within participants, particularly with longitudinal data (Demidenko 2013). This is the case both for dietary and anthropometric variables. In the case of anthropometric data, each season nests three measurements from each participant. In this case, models include random effects for each season, (each season is assigned a different intercept, estimated by the model, a general across the board error term). All correlations calculated reflect the linear relationship between variables (Pearson method).

ANTHROPOMETRIC MEASUREMENTS

Despite limitations, the use of anthropometric measurements has been recommended as indicators of nutritional and health status. While the use of Body Max Index (BMI) may result in misclassification because of varying proportions of bone mass, muscle mass, and fluids to body contributions. The use of BMI coupled with multiple skinfolds improves the quality of health assessments, as does the inclusion of other variables such as level of physical activity, history of overweight (age of onset, duration, and weight fluctuation patterns). These indicators are then matched with risk factors such as elevated blood pressure, elevated risk of coronary heart disease, and non-insulin-dependent diabetes (WHO 1995). In this research, anthropometric data was restricted to collection of height, weight, and skinfolds, as detailed below (data on arm and waist circumference were collected but not yet interpreted).

Height, BMI and body fat

From a practical point of view, BMI values provide a good first approach for evaluating weight status. BMI for adults was calculated as the weight in kilograms divided by the square of height in meters; BMI for age was calculated for adolescent females and males according to charts developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (CDC 2001). Adults were categorized according to BMI values as underweight=BMI lower than 18.5, normal=BMI between 18.6 and 24.9, overweight=BMI between 25 and 29, and obese=BMI equals or above 30 (WHO 1995). Following the CDC guidelines for children and teenagers, BMI values below the 5th percentile were classified as underweight, 5th percentile up to 85th percentile as healthy weight, 5th to less than 95th percentile as overweight, and equal to or greater than the 95th percentile as heavy weight or obese.

Upper-arm muscle area (UMA) is calculated as a function of upper arm circumference and triceps skinfold [[Upper arm circumference – (Triceps skinfold x π)]2/ (4 x π), in (Frisancho 1990)]. UMA was calculated for male and female adolescents as a function of height and age, and for adults as a function of age. Low muscle status is associated with poor nutrition, and high muscle status can be associated with good nutrition. Given that UMA is often overestimated for individuals considered obese, these were excluded for some of the analyses.

The reference values used to calculate z-scores and the interpretation of such values for all measurements were made as recommended by the (WHO 1995). Height by age z-score values (HAZ) were used as an indicator of long term physical status, and weight by height z-score values (WHZ) as a short-term physical status indicator.

ANTHROPOMETRIC DATA COLLECTION

Anthropometric measurements were conducted in a total of 65 individuals (male and female), of which 40 were adult women between the ages of 19 to 64 years, 25 adolescents between the ages of 12 and 15 (Table 66). The data was collected three times during the year: May 2014, September 2014, and January 2015. However, not all individuals were measured every single time, due to them being occasionally absent (often because of travel to other communities or nearby towns). Adults' and adolescents' standing heights and weights were collected in their homes, and a level was utilized to ensure there were no floor angles influencing the resulting values. Heights were measured using a Portable Stadiometer (Seca 213), and weight was measured using a digital scale (G-Tech Glass 200). Arm circumference and waist circumference (just above the uppermost lateral border of the right ilium) were measured using a measuring tape, and triceps and subscapular skinfolds were measured using a caliper (CESCORF). During each of the three measurement times, a single measure was made, except for weight and skinfolds, which were measured three times each time, and averages were used for analysis. Measurements followed the 2007 NHANES Anthropometry Procedures Manual.

Table 66. Sample size for each anthropometric measurements data collection period

	Adult Women age 19-34	**Adult Women age 35-65**	**Adolescent females age 12-14**	**Adolescent males age 12-14**
May/June 2014	20	19	10	15
Sept/Oct 2014	15 [a]	19	11 [b]	14 [c]
Jan/Feb 2015	12 [d]	14	11 [e]	12 [d]

[a] Of the 5 human subjects missing, 1 moved out of community, 2 were pregnant, and 2 were working in other communities. [b] One adolescent was included because she turned 12; [c] one adolescent was travelling, [d] sample size was considerably reduced during vacations/study periods, when participants traveled to other communities, towns, and cities. [e] One adolescent moved to the community and was later included, while another moved away and was excluded.

RESULTS

AMANÃ HOUSEHOLD AND PRODUCTIVE ACTIVITIES

Amanã is a place in which people have mixed subsistence strategies, and most everyone makes *farinha* and has a *roça* (manioc field) intercropped with a few other food plants for consumption. Of the 48 households in the communities, including the ones in which elderly residents lived alone or were attended to by a relative, 83% produced manioc subsistence and/or sale in the previous year. Farinha, made from manioc, is the main staple in this region, and its significance goes beyond its economic importance, although it is also the most commercialized agricultural product (Chapter 2 presents a detailed description of residents' diets). The average number of household members for the three communities studied was 5.4, with the maximum 9, and the minimum 1 member.

A few men identify themselves as fishermen, selling fish throughout the year, and a good portion fish *pirarucu* during one season annually, when the whole community is involved. Adult men camp at nearby lakes, returning to their home communities sporadically in rotational shifts. In some households, crops other than farinha are commercialized, banana being the most important (a third of households reported commercializing it). All children in the communities studied attend school, and are active members in the household, either contributing with work inside their homes or to other activities their parents or older siblings might be involved in (Chapter 1 details some of the most important activities in the communities and gives some examples of adolescents' participation from an emic perspective, using their photographs and narratives).

Social benefits are among the most important sources of household income in the communities, especially when no member is a wage earner, or when the household does not have available labor for the physical demands of *farinha* production. Social benefits range from retirement and disease pensions, to fisherman governmental insurance, to conditional cash transfers, such as from Bolsa Família or Bolsa Floresta (household income and dynamics are discussed in chapter 3). Of all households, 56% recognized social benefits as their most important income, followed by wage jobs (23%) and agriculture (19%). Basketry work, mostly conducted by women, may also represent an important income during certain months (one house in all 48 identified it as the most important income source). Most wage jobs are associated with the secondary school in the largest community, or in elementary schools in smaller communities, including a regional coordinator, as well as about a dozen teaching positions, and a few cooks and groundskeepers. These activities are intrinsically related to diets and physical activity, reflecting in mothers' and adolescents' health statuses.

ANTHROPOMETRY

This section provides a summary of the anthropometric results for all participants in order to evaluate health status. A detailed analysis of the anthropometric data and seasonal variation is reported on Appendix 2.

GROWTH STATUS: LONG TERM NUTRITION

Height-for-age (HAZ)

The mean age for adult women was 37 and the mean height 1.51 cm (Table 67). Stunting occurred in a significant portion of the adult females in this population (47.1%), with a total of 82% considered either stunted or below average (Table 69).

Table 67. Summary of age and height of adult women

	Min	**Max**	**Mean**	**S.D.**
Age	20	65	38.5	
Height (meters)	1.40	1.62	1.52	0.05

For adolescent females, the mean age was 13.1, and the mean height 1.50 cm and for adolescent males, values were 13.5 and 1.53 cm respectively (Table 67). The degree of stunting among adolescent females and males was significantly lower than among adult females, with adolescent males presenting the highest HAZ figures.

Table 68. Summary of age and height of adolescent females and males

Height (meters)	**Min**	**Max**	**Mean**	**S.D.**
Adolescent females	1.43	1.58	1.50	0.06
Adolescent males	1.40	1.71	1.53	0.08

HAZ for adolescent females and males did not differ significantly, although on average adolescent females tended to peak at the below average categories and males at the average category (Figure 67).

Table 69. Growth status category summary for all age groups in population across seasons.

	Adult mothers		**Adolescent females**		**Adolescent males**	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*
Short/Stunted	16	47.1	7	20.8	8	19.4
Below average	11	32.4	13	40.9	14	34.1
Average	7	20.6	12	37.3	19	46.5
Above Average	0	0	0	0	0	0
Tall	0	0	0	0	0	0

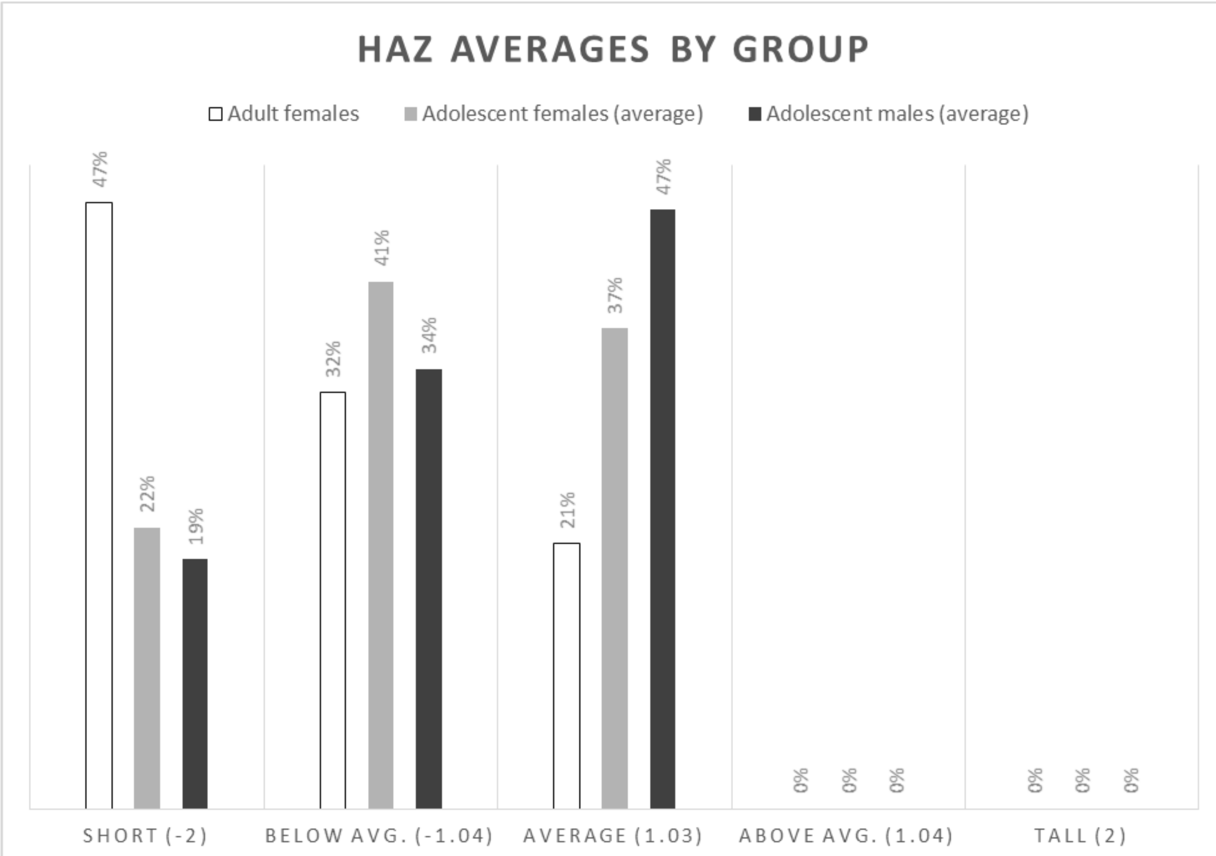


Figure 67. HAZ average by age group

Table 70. Adolescents HAZ by gender across seasons

Age/gender group	***Adolescent females***		***Adolescent males***		***Adult mothers***	
	M	*SD*	*M*	*SD*	*M*	*SD*
Height-for-age z-scores	-1.33	0.76	-1.20	0.86	-1.70 [a]	0.84

[a] Adolescent males and females presented significantly higher HAZ scores compared to adult mothers ($p<0.01$ and $p<0.05$ respectively)

WEIGHT STATUS: SHORT TERM NUTRITION

Body Mass Index (BMI)

The average BMI for female adults was 27.9 (Table 71), and there were no significant differences between age and season (see Appendix 2). More than 65% of the adult women in this study had BMI values in the overweight or obese category (Table 72). The percentage of female adults considered overweight (average 28.5%) in this population is lower than the national and north rural 2008-2009 estimates, respectively 48% and 47.4% (IBGE 2010); on the other hand, the percentage obese (average 33.8%) is marked and in fact more than double the national and rural regional estimates of 16.9% and 15.5% respectively, for all data points measured.

Table 71. BMI by age group and gender.

Age/gender group	**Adolescent females**		**Adolescent males**		**Adult mothers**	
	M	*SD*	*M*	*SD*	*M*	*SD*
BMI	19.2	1.9	18.4	1.7	27.9	5.4

Differences between adult women and adolescents BMI are apparent: while adolescents' average BMI is 19.2 for females and 18.4 for males, adult females' average is 27.9 (Table 71). Adolescent females and male BMIs were concentrated in the average category (Table 72), with categories similar to weight-for-height (Table 73).

Table 72. BMI categories by age and gender groups (average across seasons).

	Adult mothers		**Adolescent females**		**Adolescent males**	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*
Underweight	0	0	0	0	1	7.3
Average	10.3	32.6	10	96.8	12.7	92.7
Overweight	9.3	29.5	0.3	3.2	0	0
Obese	12	37.9	0	0	0	0

Weight-for-height measures are only appropriate for narrow age categories and BMI for age has not been validated as an indicator for adolescents, and is less commonly used in the literature (WHO 1995). Therefore, both indicators are presented here for adolescents. Based on BMI values, one male adolescent was classified as underweight for all three measurements in time, and one adolescent female was classified as overweight on one measurement in the transition season (Table 72). Using weight-for-height, adolescents were in the average category in all seasons (Table 73), except for one male adolescent under the below average category in the rainy season.

For female adults, BMI values had moderate to high positive linear correlation with arm fat index z scores (AFIZ), with the coefficient correlation above 0.60 for all three measurements through time. For adolescent females, BMI was weakly correlated with AFIZ for the first and second measurements and moderately correlated for the last one (coefficient equals 0.37, 0.42 and 0.53 respectively). For adolescent males, however, BMI had a negative linear correlation with AFIZ for the first two data points and was weakly correlated in the last one (coefficient equals -0.06, -0.30, and 0.17). These correlations indicate that BMI may not be the most appropriate measure to evaluate adiposity for adolescent males.

Weight-for-height (WHZ)

There was no occurrence of wasting among adolescent females and adolescent males, and the vast majority of the subjects presented WHZ z-score values in the average category.

Table 73. Weight-for-height for female and male adolescents across seasons.

Weight-for-Height	**Adolescent females**						**Adolescent males**					
Season	*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Low weight	0	0	0	0	0	0	0	0	0	0	0	0
Below average	0	0	0	0	0	0	1	7	0	0	0	0
Average	10	100	11	100	11	100	14	93	14	100	11	100
Above average	0	0	0	0	0	0	0	0	0	0	0	0
Excess fat	0	0	0	0	0	0	0	0	0	0	0	0

All female adolescent participants had WHZ in the average category, with a mean value of -0.06 (Table 75). The mean weight for female adolescents, combining all seasons, was 43.6 kilograms, and for adolescent males the mean weight was 43.2 kilograms (Table 74). All male adolescent except one (WHZ below average in the rainy season) had WHZ in the average category across seasons, with mean value equals to -0.25 (Table 75).

Table 74. Summary of weight values adolescent females and males

Weight (kg)	**Min**	**Max**	**Mean**	**S.D.**
Adolescent females	35.7	54.1	43.6	6.5
Adolescent males	31.8	57.2	43.2	7.5
Adult females	42	101.5	64.5	13.7

Considering that WHZ is a short term physical status indicator, differences between seasons are expected to appear when there is vulnerability in health status. However, there were no significant differences between measurements taken in different seasons for each group. Adolescent females' *p*-values were equal to 0.27, 0.49 and 0.08 comparing the three measurements in time, and for adolescent males the values were 0.55, 0.90 and 0.69. There were no gender differences for adolescents (Table 75).

Table 75. Adolescents WHZ by gender for three data collection periods

	Adolescent females		**Adolescent males**	
Weight-for-Height	*Mean*	*SD*	*Mean*	*SD*
Rainy season	-0.24	0.29	-0.30	0.33
Dry season	-0.05	0.47	-0.22	0.41
Transition season	-0.05	0.45	-0.19	0.47

p=0.66, p=0.34, p=0.5 respectively between genders for rainy, dry and transition seasons.

MUSCLE STATUS AND BODY FAT

Detailed muscle status across seasons for all gender and age groups are outlined in Appendix 2. Overall, z-scores for upper arm muscle area calculated by age (ZUMA-age) indicated good nutrition in all groups and genders. For adult females, 87.7% were in the average category, and the remaining were in the above average category. Similarly, the majority of the adolescents ZUMA-age values were in the average reference range (at least 78% of females, and almost 70% of all males across measurements), although others fell into the below average or low muscle categories. For adolescent males this is mostly a reflection of their relatively lower weight compared to females (Table 71), as well as the large percentage of adolescents with short or below average stature for their age, as shown through the analysis of HAZ (Table 69).

BODY FAT

To increase the effectiveness of the fat status diagnosis for individuals, it is important to have multiple measurement indicators, such as the sum of triceps and subscapular skinfold thickness (Frisancho 1990). Individuals whose z-scores fall below the 85.1 percentile can be considered to have fat levels associated with positive health (WHO 1995). Other recommended calculations were analyzed by season (in Appendix 2), and did not differ significantly from sum of skinfolds z-scores (ZTSF+SSF). This measure was then selected as an indicator for the overall analysis in this chapter since it includes both skinfold thickness measurements.

Mean ZTSF+SSF for adult mothers was 0.57, while for adolescent females this value was -0.31, and -0.61 for adolescent males (Table 76).

Table 76. ZTSF+SSF by age group and gender.

Age/gender group	**Adolescent females**		**Adolescent males**		**Adult mothers**	
	M	*SD*	*M*	*SD*	*M*	*SD*
ZTSF+SSF	-0.31	0.63	-0.61	0.22	0.57	0.97

Considering BMI alone, 37.9% of the female adults were in the obese category, and using ZTSF+SSF the percentage was lowered to 31.6% (Table 77). Combining the excess fat and above average categories, these numbers were 67.4% and 45.3 % respectively. For the three data points, female and male adolescents ZTSF+SSF were lower than those for adult females (p< 0.00 for all cases).

Table 77. ZTSF+SSF categories by age and gender groups (average across seasons).

	Adult mothers		**Adolescent females**		**Adolescent males**	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*
Lean	0	0	0	0	0	0
Below avg.	0.7	2.1	3	30	0	0
Average	16.7	52.6	6.7	63.7	14	100
Above avg.	4.3	13.7	0.7	6.3	0	0
Excess Fat	10	31.6	0	0	0	0

ANALYSIS: ANTHROPOMETRIC AND DIETARY VARIABLE CORRELATIONS

To address the main question of this chapter about the effects of the BFP money management on health status of mothers and adolescent's, correlations among the most relevant variables were assessed.

From these correlations, one can observe a cluster of positive association between some dependent variables. This is observed in the case of adult mothers (Figure 68) and adolescent females (Figure 69) between BMI values, sum of skinfolds, and Arm Fat Index (as well as weight-for-height for female adolescents), which indicate BMI does reflect fat status. Also, part of this cluster for mothers is daily kilocalories from manioc flour, fish, total kilocalories, and total fat. Considering the dietary variables, kilocalories from manioc flour and fish presented a high relative positive correlation among the variables considered.

For female adolescents, highly industrialized foods stand out in a cluster of height-for-age, BMI, and sum of skinfolds cluster, whereas total kilocalories unexpectedly seem to be negatively correlated (even though the value is close to zero). For adolescent males, as mentioned previously, BMI and measurements of fat status were not highly correlated, while consumption of manioc flour was relatively highly correlated with BMI and weight-for-height (Figure 70). While highly industrialized foods were positively correlated with total Kcal and total fat consumption, in the case of male adolescents they were negatively correlated with both

BMI and weight-for-height, differing from adolescent females' results that indicated gender may play a role in the relationship.

The main research questions of this chapter address the effects of Bolsa Família modes of money management on diet and health status of mothers and adolescents living in the Amanã Reserve. The key independent variable considered was mode of BFP management. Household income per capita was included in the model, given that it appeared as an important factor influencing money management and livelihoods (Chapter 3). The main dependent variables used were:

- BMI for mothers and female adolescents
- Weight-for-height for adolescents, females and males
- Height-for-age in adolescents, females and males: actual numbers were used initially, and then categories;
- Percentage of the required total daily kilocalories from key food items: manioc flour, fish, fried bananas, vegetable oil, fried bananas and highly industrialized foods (including the same items as in Chapters 2 and 4).
- The required total daily kilocalories for mothers was considered as the average between rainy and dry season (2150Kcal), and for adolescent's calculations based on weight were respectively 2027 Kcal and 2400Kcal for adolescent females and males (details on calculations explained in Chapter 2).

Figure 68. Anthropometric and dietary intake variable correlations for adult mothers.

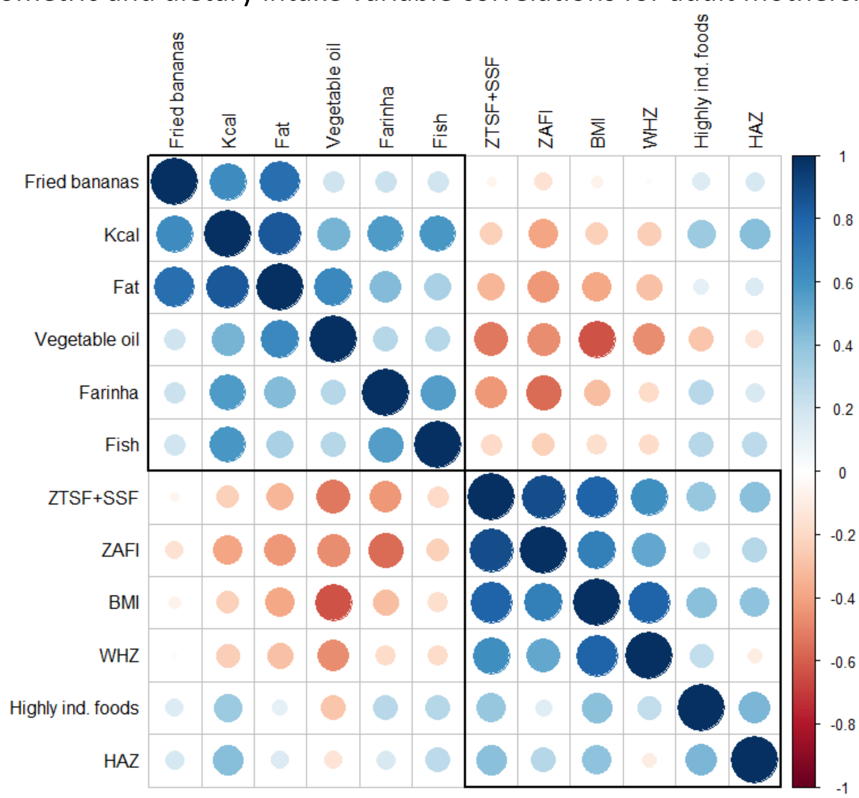


Figure 69. Anthropometric and dietary intake variables correlations for adolescent females

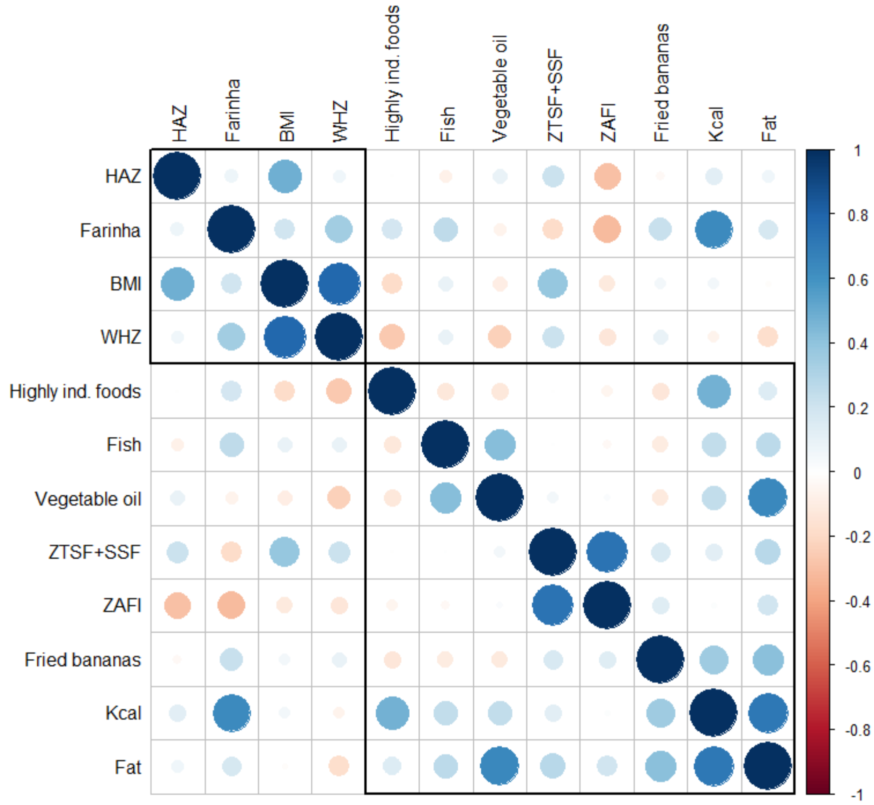


Figure 70. Anthropometric and dietary intake variable correlations for adolescent males.

BOLSA FAMÍLIA MANAGEMENT EFFECTS ON DIET AND HEALTH STATUS

In this section, models using the variables outlined above were formulated to analyze the second research question of this chapter concerning the relationships between income and Bolsa Família management, as well as diets and health status. The R software outputs for all statistical models are included in the Chapter 5 Appendix document, in order of appearance.

EFFECTS OF BFP BENEFIT MANAGEMENT ON WEIGHT STATUS

Given the associations observed in the analysis section, weight status was operationalized as BMI, weight-for-height, and/or sum of skinfold depending on the age group and gender. Initially, however, a general model using all participants' measurements was considered given the effects of Bolsa Família modes of money management on BMI:

BMI = BFP benefit management + income/capita + age group/gender + total Kcal + (season |id) [v]

Results show that, on average, BMI increases by 2.08 units when money is managed by women in the household ($p<0.05$), controlling for age group and gender, total kcal consumed, and income per capita (Table 78). Also, BMI values of female and male adolescents are on average 7.9 and 8.7 lower than that of mothers respectively ($p<0.00$).

Table 78. Model results for BFP benefit management effects on BMI for all participants.

Fixed Effects	**Estimate**	**t-statistics**
Constant	30.68 ***	21.0
Personal woman management	2.08 *	2.22
Personal man management	-0.56	0.45
Income per capita	-0.01 **	-3.08
Adolescent females	-7.90 ***	-7.78
Adolescent males	-8.71 ***	-9.58
Total Kcal consumed	0.00	-0.74

N=152, 54 participants, 3 seasons ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Bolsa Família and mothers' weight status

Considering mothers specifically, descriptive statistics suggests an association between BMI and personal woman BFP benefit management (Figure 71).

[v] *(season|id)* assumes random intercepts by subject as well as random slopes varying across the three seasons.

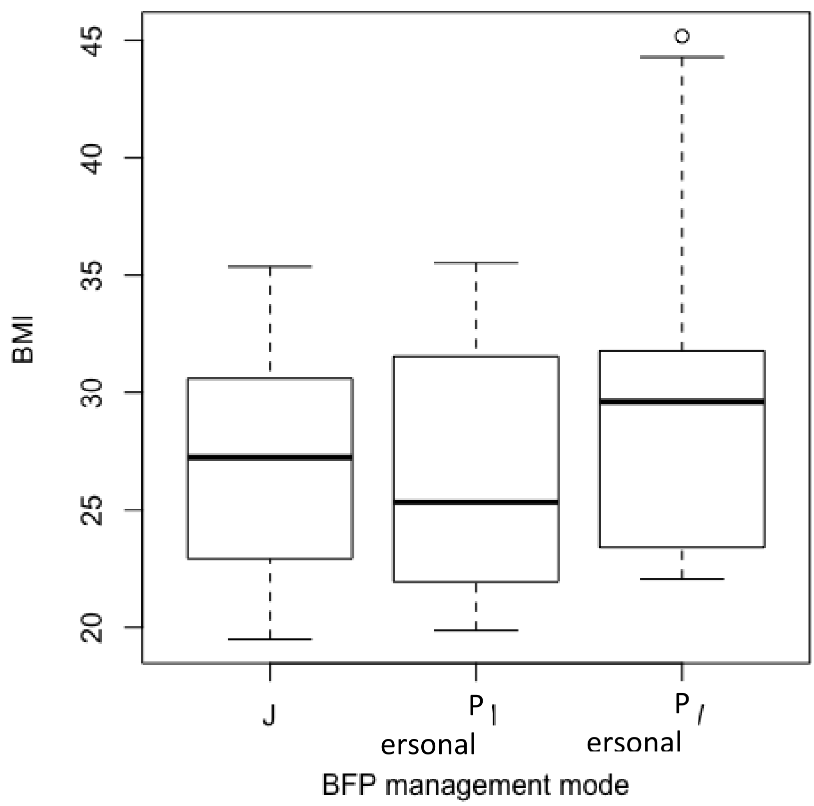


Figure 71. Mother's BMI by BFP benefit household management mode

Mothers had great variation in BMI, with the minimum value in the average category (19.5), and maximum value in the obese category (45.2). In order to understand the factors explaining this variation in weight status for mothers, their data was singled out and analyzed using two statistical models with different dependent variables: first using BMI values and second with sum of skinfold values. The models and results (Table 79 and Table 80) are presented below:

BMI = BFP benefit management + income/capita + (1 /id) [w]

Sum of skinfolds = BFP benefit management + income/capita + (1 /id) [b]

[w] Assumes random intercepts by subject.

Table 79. Model results for BFP benefit management effects on BMI for mothers.

Fixed Effects	Estimate	t-statistics
Constant	30.15 ***	12.7
Personal woman management	3.66 .	1.70
Personal man management	-0.10	-0.04
Income per capita	-0.01 .	-1.72

N=152, 54 participants, 3 seasons ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Table 80. Model results for BFP benefit management effects on sum of skinfolds for mothers.

Fixed Effects	Estimate	t-statistics
Constant	1.12 *	2.71
Personal woman management	0.53	1.42
Personal man management	-0.03	-0.08
Income per capita	-0.00 .	-2.04

N=152, 54 participants, 3 seasons ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Bolsa Família and adolescents weight status

Over 90% of the participants, both for female and male adolescents, were in the average weight status category (Table 66, Figure 72) independent of modes of management of the BFP in the household. There is no indication of an effect of the mode of benefit management or income per capita on weight-for-height or sum of skinfolds of adolescents. However, gender has an effect on sum of skinfolds and adolescent males tend to have z-scores -0.36 lower than adolescent females (Figure 73), even though the vast majority of adolescents, independent of gender, are in the average category.

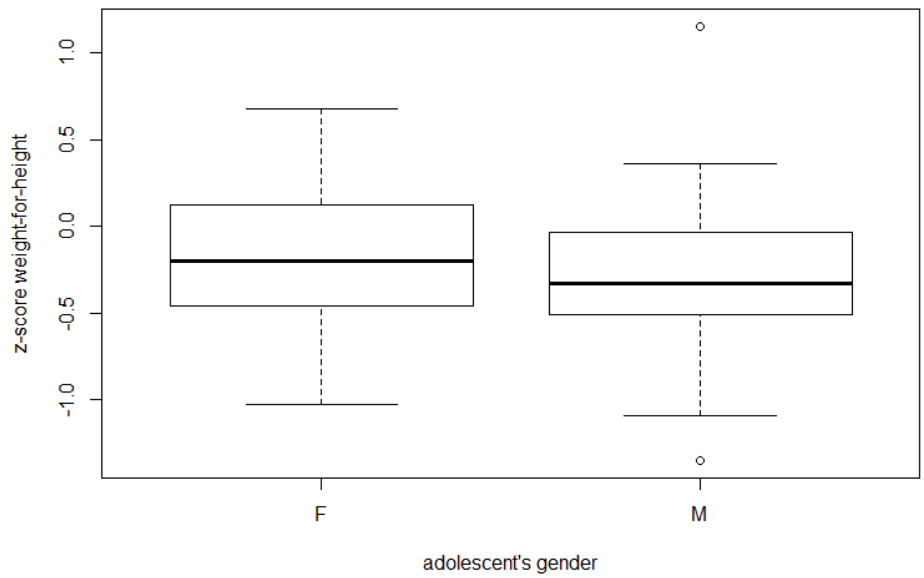


Figure 72. Weight-for-height z-scores by gender for adolescents

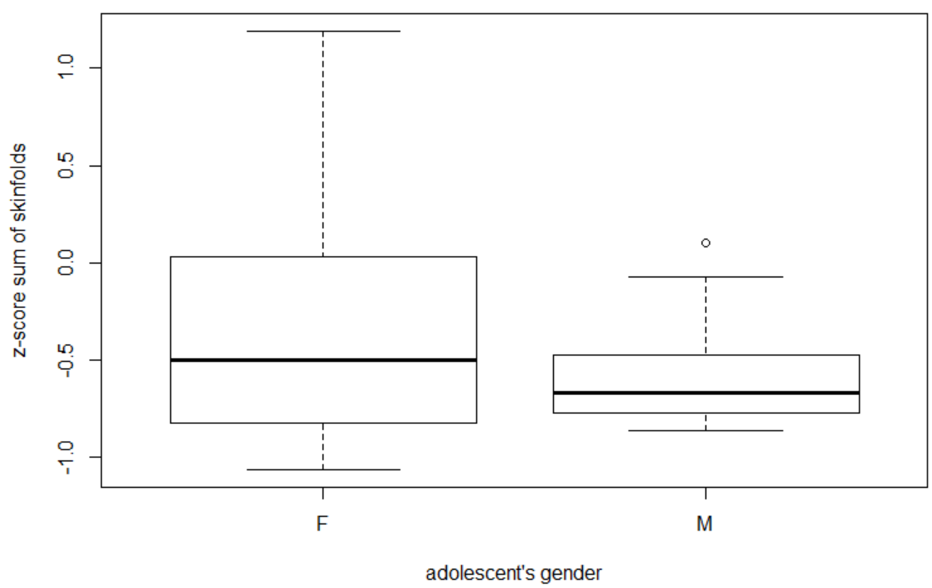


Figure 73. Sum of skinfolds z-scores by gender for adolescents

Given that BMI by age seemed as not an appropriate measure for weight status for male adolescents (as presented in the Anthropometry section, BMI is negatively correlated with fat status), the models used previously were modified, including weight-for-height and sum of skinfolds as the dependent variables, only considering adolescents' data. The models used to evaluate the effects of the BFP management on weight status for adolescents were:

WHZ = BFP manag. + BFP % of income + %kcal/daily requir. + gender + (season /id) [a]

ZTSF+SSF = BFP manag. + BFP % of income + %kcal/daily requir. + gender + (season /id) [a]

On average, the higher the BFP value is in terms of a percentage of the average income, WHZ z-scores of adolescents increase 1.46 ($p<0.05$), controlling for gender and total Kcal consumed as a function of daily requirements (Table 81).

Table 81. Model results for BFP benefit management effects on WHZ for adolescents.

Fixed Effects	**Estimate**	**t-statistics**
Constant	-0.79	-2.26 *
Personal woman management	0.35 .	1.78
Personal man management	-0.08	-0.3
%kcal/daily require.	-0.00	-0.43
BFP% of income	1.46 *	-0.43
Gender (males)	-0.06	2.46

N=55, 22 participants, 3 seasons ***p<0.001, **p<0.01, *p<0.05, . p<0.1

On the other hand, considering sum of skinfolds z-scores, no significant effects were detected (Table 82).

Table 82. Model results for BFP benefit management effects on ZTSF+SSF for adolescents.

Fixed Effects	**Estimate**	**t-statistics**
Constant	-0.74	-2.51 *
Personal woman management	0.05	0.31
Personal man management	-0.41 .	-1.77
BFP% of income	0.78	-1.54
Kcal intake (% of daily requirement)	-0.00	-0.42
Gender (males)	-0.19	-1.24

N=152, 54 participants, 3 seasons ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Effects of BFP benefit management on food item intake

Based on results from Chapter 2, food items representing major kilocalorie contribution in diets, and greater variation in kilocalorie intake among age groups and gender, were included in this analysis. These were: manioc flour, fish, fried bananas, vegetable oil added to meat dishes, and highly industrialized foods. Each of these items were considered as dependent variables to investigate any significant effects of benefit management on kilocalorie intake of each item, as well as differences among mothers and adolescent females and males. The general model used was:

Food item [x] *= BFP manag. + income/capita + age group/gender + (season /id)* [a]

Considering absolute Kilocalorie intake values and percentage of daily Kilocalorie required values, no statistical differences were detected for intake between mothers and adolescent females and males (Table *83*). In terms of variation in intake of different food items, the data suggests mothers are relying more heavily on manioc flour for meeting their energy needs, at least compared to adolescent males, who are on average consuming 22.6% less of the daily kilocalorie requirement from manioc flour compared to mothers ($p<0.001$), controlling for all other variables

[x] Percentage of the daily total kilocalorie requirement provided by a particular food item.

Table 83. Model results for BFP benefit management effects on total daily kcal and food items for all participants.

Fixed Effects	Total daily kcal	% daily kcal requirem.	% Manioc flour	% Fish	% Fried bananas	% Vegetable oil	% Highly ind. foods
Constant	1761.74 (4.30) ***	83.03 (7.13) ***	12.4 (2.65)*	6.62 (3.56) ***	-5.40 (-1.15) *	-2.00 (-0.73)	-7.39 (0.33)
Personal woman management	-174.03 (-0.64)	-8.15 (-0.65)	0.90 (-0.35)	0.63 (0.63)	**-5.64 (-2.22) ***	0.13 (0.09)	**5.53 (2.06) ***
Personal man management	188.37 (0.53)	8.41 (0.51)	2.21 (0.63)	-1.69 (-1.26)	-3.06 (-0.90)	-1.84 (-0.90)	-0.64 (0.86)
Income per capita	0.16 (0.93)	-0.00 (0.04)	-0.02 (-1.51)	-0.01 (-2.29) *	0.00 (0.24)	-0.00 (-0.13)	0.00 (0.13)
Adolescent females	374.55 (0.21)	**23.73 (1.75) .**	-8.04 (-2.72)	-1.39 (-1.23)	0.52 (0.18)	0.58 (0.33)	**5.27 (1.72) .**
Adolescent males	**450.20 (1.73) .**	10.41 (0.86)	**-22.59 (-8.53) ***	-1.04 (-1.02)	-0.50 (-0.19)	-0.20 (-0.13)	4.25 (1.56)
% daily kcal requirem.	NA	NA	**0.19 (6.23) ***	0.05 (3.97) ***	0.17 (5.10) ***	0.08 (4.55) ***	**0.09 (3.86) ***

t-statistics in parentheses. N=152, 54 participants, 3 seasons ***p<0.001, **p<0.01, *p<0.05, . p<0.

There is a significant effect from the mode of management of the BFP benefit on the consumption of fried bananas and highly industrialized foods for all participants. Compared to households where the money is managed as a joint fund, consumption of fried bananas is, on average, lower than when the benefit is managed by the woman (-5.6% of the daily energy requirement, $p<0.05$). On average, consumption of highly industrialized foods is 5.5% higher for mothers and adolescents ($p<0.05$), when the BFP benefit is managed by the mother in the household, again controlling for income, age group, gender and % Kcal requirement consumed from all food types.

Among the highly industrialized food items in adolescent males' diets, the most frequently consumed items were breads and artificially flavored drinks (juice powder), 15% each, followed by ice pops (14%), sodas (11%), and cookies (9%). The other 36% are accounted for by canned meat, corn puffs, sausages, wheat cake, chewing gum, lollipop, mint candy, guava sweet, hot pepper sauce, canned peas and carrots, and canned fish, from higher to lower frequency of consumption. For adolescent females, the most frequently consumed items were breads and ice pops (16% each), followed by cookies (13%), sausage, canned meat, and chewing gum, which accounted for 7% each. All others had lower frequencies of consumption including Mucilon starch-thickened snacks, sodas, wheat cake, artificially flavored drinks (juice powder), lollipop, chocolate, corn puffs, and guava sweets.

Along the same lines as described above, for mothers, bread accounted for 34% of the frequency in consumption of highly industrialized items, followed by artificial sweetener at 20% (this is only due to one participant who had diabetes and consumed sweetener many times a day). Canned meat, sausages, and artificially powdered drinks each accounted for 9%, and all others accounted for less than 8% (cookies, wheat cake, ice pops, and ketchup).

EFFECTS OF BFP BENEFIT MANAGEMENT ON GROWTH STATUS

Effects of benefit money management in the household on height-for-age was evaluated exclusively for adolescents, since HAZ reflects long-term growth and adolescents are experiencing a period of rapid changes sensitive to nutritional variation. There was no significant effect of BFP money management on height-for-age (Table 84).

Table 84. Model results for BFP benefit management effects on HAZ for adolescents.

Fixed Effects	**Estimate**	**t-statistics**
Constant	-1.45	-2.30
Personal woman management	0.04	0.11
Personal man management	0.13	0.26
Kcal intake (% of daily requirement)	0.00	2.06
Gender (males)	0.15	0.46
Income per capita	-0.00	-0.51

N=55, 22 participants, 3 seasons ***p<0.001, **p<0.01, *p<0.05, . p<0.1

Indeed, descriptive crosstabs with HAZ and household money management (Figure 75), and income per capita in the household show no pattern of association (Figure 74).

Moreover, when considering all participants, results show that HAZ z-scores for both female and male adolescents are on average 0.5 higher than HAZ of mothers (p<0.001), and the descriptive data presented previously shows a larger proportion of mothers in the short category compared to adolescents (Table 69).

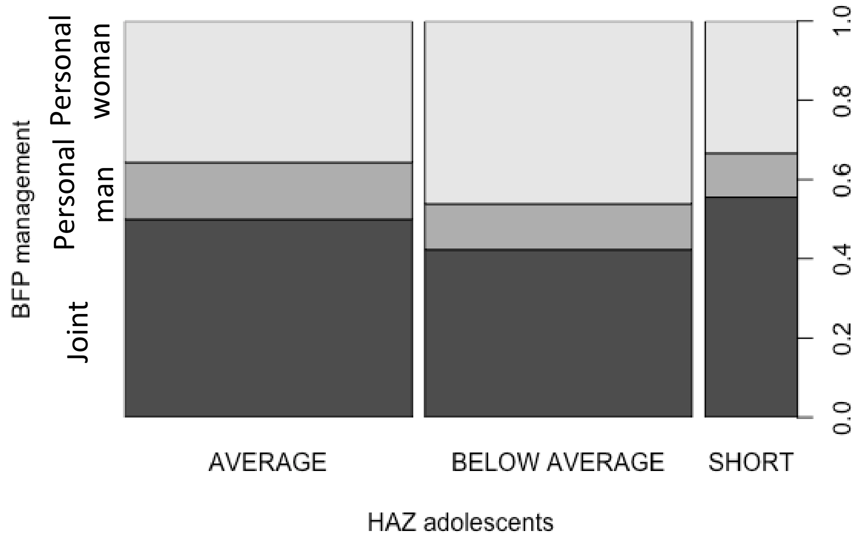


Figure 74. BFP management mode by HAZ for adolescents.

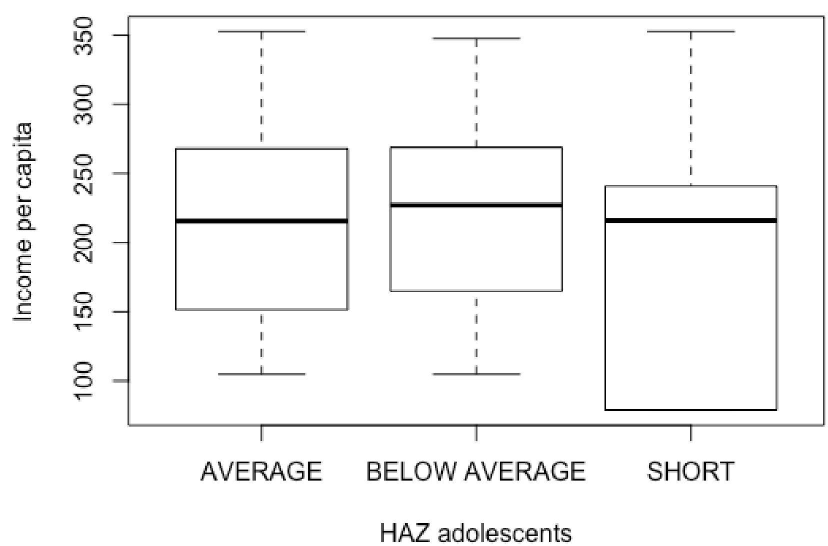


Figure 75. Monthly household income per capita (in Brazilian *reais*) by HAZ for adolescents

SUMMARY OF RESULTS

Anthropometric measurements show compounding factors associated with poor health status for adult women, compared to adolescents. The percentage of stunted adolescents is less than half that of adult women, indicating a generational improvement. While 20% of adolescents are currently in the stunted category, there was no evidence of a double-burden for this group, at least between ages 12 and 14 with no adolescents in the obese category. On the other hand, 32% of the adult women in the sample were in the excess fat category considering sum of skinfolds (38 % considering BMI values). Curiously, when looking at mothers specifically, results show their total kilocalorie intake is less that than of adolescents, considering estimated daily requirements (Table 85). This is intriguing and possible explanations are addressed in the discussion section below.

Table 85. Summary of results for all participants

	Mothers	**Adolescent females**	**Adolescent males**
HAZ (mean)	-1.7*	-1.3	-1.2
BMI (mean)	27.9**	19.2	18.4
WHZ (mean)	NA	-0.11	-0.24
ZTSF+SSF	0.57***	-0.31	-0.61
Stunted	47.1%	20.8%	19.4%
Obese	37.9%	0	0
Excess fat	31.6%	0	0
Manioc flour (average % intake of from daily Kcal requirement) [a]	12.4 (reference)*	No significant difference	22.6 lower
Personal mother money management compared to joint management – reference [a]	Higher BMI by 2.08; Higher consumption of highly industrialized foods (5.53% more of Kcal daily requirement); Lower consumption of fried bananas (5.6% less of Kcal daily requirement)	Higher BMI by 2.08; Higher consumption of highly industrialized foods (5.53% more of Kcal daily requirement); Lower consumption of fried bananas (5.6% less of Kcal daily requirement)	Higher BMI by 2.08; Higher consumption of highly industrialized foods (5.53% more of Kcal daily requirement); Lower consumption of fried bananas (5.6% less of Kcal daily requirement)

[a] LMM controlling for BFP management mode, household income per capita, age group and gender, percentage of Kcal requirements consumed with random intercept and slope of individual by season; [c] small sample size= 6 households

The effects of mothers controlling the BFP benefit in the household are apparent. Compared to a joint management, mothers and adolescents living in households where the benefit is controlled by the mother tend to have a higher BMI, as well as consume a higher percentage of Kilocalories from highly industrialized foods. Mother's control over the BFP management in the household was also associated with a lower % of daily Kilocalories requirement coming from fried bananas (Table 85).

DISCUSSION

In this section I compare the anthropometric results with the literature and discuss the trends observed in light of the BFP. Following that, I outline trends in the health and diet of residents of Amanã, organized by age group and gender, focusing on the effects of mothers' personal management of the BFP benefit within the household. I argue that a mother's health status may be the most at risk from an immediate perspective, given the rates of obesity found. Also, for adolescent females, the increase in BMI associated with the BFP benefit managed by the mother presents a potential detrimental effect on their health in the near future.

HEALTH STATUS OF ADULT WOMEN AND ADOLESCENTS IN CONTEXT

Daily kilocalorie intake data from 24-hour recalls show no difference in intake compared to daily requirements for mothers and adolescents. However, BMI for adult women are on average higher than that of adolescents, independent of gender. Possible explanations for this dissonance have to do with the method and analysis. First, mothers may be underestimating amounts of food consumed, or undereating in certain periods. The literature shows BMI as one of the main predictors of under-reporting in repeated 24-hour recalls (Johansson et al. 2001), a consistent pattern among individuals who experience stigma associated with being overweight or obese (Poslusna et al. 2009). Another possible factor is the lack of data collected about physical exercise level. Physical level was considered constant by season across all individuals, based on (WHO 1995) estimates. Lastly, parasitic infections may play a role in this dissonance since levels and types of infections affect nutritional absorption differently, and assessing the stresses from these pervasive infections in the rural Amazon, where it is commonly perceived as “normal and unavoidable” (S. Tanner et al. 2009), 651), is yet a challenge.

AMANÃ IN CONTEXT: BOLSA FAMÍLIA AND LONG TERM GROWTH

There was no evidence of mothers control over the BFP benefit having an effect on adolescents’ long term development, as measured by height-for-age (HAZ). Nonetheless, the significant difference in HAZ comparing adult women and adolescents does raise a question of which factors may have improved long-term growth. The BFP program itself may be one of the factors accounting for the generational improvement, since it has been recorded as one of the most noticeable impact in various regions of the Amazon (e.g. Peralta and Lima 2014, Piperata, Spence, et al. 2011).

To illustrate the importance of the BFP in rural communities of the Amazon, Piperata et al. (2011) reported that 40% of households in the Caxiuanã National Forest in Pará ranked BFP as the most important source of income in 2009. In communities in the Mamirauá Sustainable Development Reserve, data from 2011 shows on average 44.2% of the household income coming from social benefits (10.7% from the BFP), and 43.2% (8.4% from the BFP) in the Amanã Sustainable Reserve respectively (Peralta and Lima 2014). Results from this research show that in the communities studied in Amanã in 2014, 60% of participating households declared social benefits were the most important source of income.

As mentioned previously, data on health status of adolescents among rural ribeirinhos of the Amazon is yet sparser than that of adults and infants. Nevertheless, there is available comprehensive data from communities located in the estuarine and seasonal floodplains of

Pará state, as well as communities in upper land areas of Caxiuanã National Forest, also in Pará. This generational improvement in long term growth is apparent only for data collected during this study in Amanã, compared to the three aforementioned cases (Table 86).

In terms of historical and environmental contexts, the National Forest of Caxiuanã may be the most directly analogous case to the Amanã Reserve, given that it is located in an upland forest region and a comparable conservation management unit established under the Brazilian system of protected areas. The productive activities and livelihoods described in Caxiuanã in 2002 and Amanã in 2014 were similar, involving swidden agriculture, predominantly for the production of *farinha,* which was widely consumed and commercialized. In both men and women participated in the production and processing of manioc, and adolescents were also active participants, although males and females contributed to different activities throughout the process. Small children frequently accompany their parents to the fields and *casa de farinha,* even before being old enough to help out, especially when childcare is unavailable.

In Amanã, the commercialization of açaí is of lesser importance compared to Caxiuanã, but the pulp is consumed in large quantities and appreciated seasonally. While Piperata (2007) describes the collection of açaí as primarily a male activity, along with hunting and fishing, in Amanã adolescents are usually the ones who collect açaí, mostly because of their greater agility. This difference may be associated to açaí production representing a non-systematic, less frequent, and mostly subsistence activity in Amanã, compared to its great commercial importance in Caxiuanã.

Table 86. Summary of results from anthropometric data published for ribeirinho populations in the rural Amazon

Reference	**Date of collection**	**Study site**	**HAZ <2 (% short)**			**WHZ<2 or BMI < 18.5 % wasted (sample size)**			**BMI > 30 (% obese)**		
Age, gender			>18, females	10-19, females	10-19, males	>18, females	10-19, females	10-19, males	>18, females	10-19, females	10-19, males
(Adams et al. 2009), collected by Neves, Siqueira and Murrieta	1990	Estuary, Marajó Island, PA	18.6%	16.3%	30%	0	0	0	2.5%	0	1.7%
(Adams et al. 2009), collected by Adams and Sanches	1996-1997	Seasonal floodplain, Ituqui Island, PA (Aracampina and São Benedito)	6.3%	39.1%	31.9%	0	0	0	26%	9-10% [a] (includes overweight)	8% [a] (includes overweight)
Silva et al. (2010)	1996	Caxiuanã, upland forest, PA	NA	NA	NA	NA	1% (wet season)	0 (wet season)	NA	42% (rainy season, includes overweight)	0 (rainy season, includes overweight)
Piperata, Spence, et al. 2011)	2002	Caxiuanã, upland forest, PA	45%	63%	45%	8%	9%	11%	31% (includes overweight)	12% (includes overweight)	0% (includes overweight)
	2009	Caxiuanã, upland forest, PA	40%	50%	55%	10%	3%	5%	19% (includes overweight)	13% (includes overweight)	0% (includes overweight)
This research	2014-2015	Amanã communities, AM	47.1% (34)	20.8 % (12)	19.4% (15)	0	0	0	37.9% (67.4% including overweight)	0 (3.2% including overweight)	0

[a] data from (Silva et al. 2010)

One fundamental difference between Amanã and Caxiuanã is the latter's location in a black water river ecosystem, known for its low fertility, which in turn affects the availability of natural resources used in subsistence and commercial activities. This environmental characteristic has been recognized as a key variable in the literature (Moran 1993), and is often taken into consideration by nutritional anthropologists (e.g. Adams 2002, Alencar et al. 2007). Although Ituqui is located in a clear water ecosystem, similar to Amanã (Amazon and Solimões respectively), Ituqui is entirely flooded seasonally, and is in relative proximity to the second largest urban area in Pará: the Santarém municipality (Silva et al. 2010).

Moreover, in 2002 government services provided to Caxiuanã, in terms of education, health, and sanitation were described as very poor (Piperata 2007). Similarly, in 2014, most households did not have pit toilets in Amanã, but an important difference was that a majority of households there had other assets. In the study area these included: running water connected to a well; a community or individual generator, which would commonly run for a few hours at night; elementary schools; a secondary school in Santo Agostinho, and a health center attended by local health agents (the latter present both in Santo Agostinho and in Nova Oeste).

Piperata et al. (2011) produced a unique longitudinal study addressing specifically the effects of BFP benefit and other incomes on the health status of ribeirinhos living in the National Forest of Caxiuanã. Their research shows the effect of BFP on health by presenting a longitudinal comparison using 2002 and 2009 anthropometric data, before and after the program was fully implemented in the region. They show a positive association between household BFP enrollments on HAZ for adolescents (Piperata et al, 2011). Using longitudinal data, they also note a more pronounced improvement and catch-up growth among males, possibly because of high pregnancy rates among adolescent girls (in this study one 12-year old was excluded from the sample for this reason).

In regards to a generational difference in HAZ, data collected in 2002 by Piperata (2007) did not show a significant difference between adults and adolescents. She concludes that no positive change in health status had occurred, associating it with continuously insufficient intake of kilocalories and disease burden, linked to poor sanitary conditions. Similar results were found by Piperata and colleagues (2011) in 2009, with high rates of stunting among adult females (40%) and adolescents (50% of females; 55% of males). Findings from this study are clearly different, given the significant evidence of HAZ differences comparing adult females (47.1% stunted) and adolescents (20.1% stunted).

Piperata, Spence, et al. (2011) argue that the BFP benefit was partially responsible for the abandonment of manioc fields by households in Caxiuanã, and show a lack or minor improvements on access to basic needs, such as clean water, education, and sanitation using data from 2002 and 2009. Taking an approach to health as linked to social determinants, it would not be surprising that the BFP would have differential effects in Amanã and Caxiuanã. As argued by (Silva et al. 2016), policies in the Amazon need to take into consideration regional particularities in order to account for potential effects. Moreover, research at the household level is necessary to understand the potential unintended consequences of a specific policy, such as the BFP, especially concerning the productive activities and consumption patterns in place (Silva et al. 2016).

Rates of stunting in adolescents in Amanã are significantly lower compared to adult women in the same communities, and in all probability, compared to adolescents living in

Caxiuanã. Despite this, there is still a significant percentage of stunting found among adolescents in Amanã, 20.8% and 19.4% for females and males respectively, as well as adolescents placed in the below average category, 40.9% and 34.1% for females and males respectively. This pattern indicates that nutritional stresses affecting children and adolescents' growth and development is still present in these communities.

AMANÃ IN CONTEXT: ADOLESCENTS' WEIGHT STATUS

This study showed no wasting among adolescents (ages 12-15) as measured by low weight-for-height. Similarly, BMI-for-age revealed minor rates of underweight (7.3%, one adolescent male – classified as underweight on three measurements). Indeed, chronic malnutrition, as measured using height-for-weight, has been identified as more of a concern than acute malnutrition (based on weight-for-height) among ribeirinhos in the Amazonian literature (e.g. Adams and Piperata 2014) as well as among indigenous groups (Godoy et al. 2005).

National data available for adolescents between ages 12 and 15 show that 3.8% of adolescents were underweight at the country level, based on BMI-for-age. Regional data aggregated for adolescents ages 10 to 19, show 3.1% as underweight in the rural north (2.6% of females, and 3.7% of males). The rates of underweight in the rural north are slightly lower than the national average, which is counterintuitive, given that it is one of the poorest regions in the country. This is mostly due to the high rates of underweight found in the northeast, and the common exclusion of populations living in locations difficult to access, such as in some rural areas of the Amazon.

Despite progress in declining underweight rates at the country level, from 10.1% to 3.7%, and 5.1% to 3% for adolescent males and females, between the 1970s and 2000s (IBGE 2010), wasting has still been reported for a few ribeirinhos (Piperata, Spence, et al. 2011) and indigenous groups such as the Shiwiar, who live in the Ecuadorian Amazon. For the latter, 21.3% of male adolescents between ages 12 and 15 were underweight and 62.3% were stunted (Blackwell et al. 2009). Another example includes various ethnic groups in the Peruvian Amazon, where 18% of children 5-11 years old were underweight and 58% were stunted (Anticona and San Sebastian 2014).

Advances in long-term and short-term growth among children and adolescents at the country level has been accelerated. Alongside improvements, however, obesity rates have been constantly rising, as seen in adult populations. From the 1970s to the 2000s a continuous increase was observed among adolescents aged 10-19 years. Obesity jumped from 0.4% to 5.9% in males, and from 0.7% to 4% in females, however the rural northern region was excluded from the first set due to a lack of data. From 2008 and 2009, obesity rates among adolescents aged 10-19 years in the rural north were 3.2% for females and 1.7% for males (IBGE 2010).

As mentioned in this chapter's introduction, recent research has shown a rise in obesity among the low income (Monteiro, Conde, and Popkin 2007), as well as in remote areas of the Amazon (Silva et al. 2016; Blackwell et al. 2009). Though the mechanisms of this change in health status among rural Amazonian populations is still poorly understood; market integration, abandonment of agricultural production, consumption of highly industrialized foods, inadequate access to basic services, as well as environmental contamination have been identified as mediating factors (Godoy et al. 2005; Blackwell et al. 2009; Nardoto et al. 2011; Piperata, Ivanova, et al. 2011; Anticona and San Sebastian 2014)

Overweight and obesity rates among adolescents living in the rural Amazon, however, are commonly low (*Table 86*). An exception is the high number of overweight female adolescents in Caxiuanã (42%), reported by (Silva et al. 2010)). The inclusion of older girls, from 10 to 19 years of age, may partially explain differences from other regions. Their data collected in 1996-1997 shows a seasonality effect on BMI, and also a gender difference: no adolescent males were considered overweight (Silva et al. 2010). Later studies in Caxiuanã also show higher overweight rates among adolescent females, compared to males, however they are much lower than rates reported previously (Piperata 2007; Piperata, Spence, et al. 2011).

Overweight and obesity patterns may be noteworthy in females between ages 15 and 19, partially due to early pregnancy. For instance, while (Houck et al. 2013) reported 0% of adolescent girls between ages 10-14 were not overweight, 40% of 15-19 year olds were overweight, including one obese. Data from this research show adolescents (12-14 years of age) overwhelmingly in the average category, both in terms of BMI-for-age and weight-for-height (Table *72* and Table *73*), without any significant seasonality effect (data in Appendix 2).

BOLSA FAMÍLIA AT AMANÃ: DIFFERENTIAL GENDER EFFECTS IN ADOLESCENTS

In this research, control over the BFP management by the mother was associated with an increase in weight status for adolescents based on BMI-for-age. From an immediate perspective, this may be considered a positive effect on their health status, especially considering Amanã as a place of dietary vulnerability. The rural Amazon in general, as well as Amanã, can be considered a place of unstable kilocalorie availability throughout the year, particularly because of the fluctuation of food resources used for subsistence and potential damage of agricultural fields by inundation, depending on the intensity of seasonal floods.

When the BFP management is controlled by the mother of adolescents in the household, female adolescents were likely to have on average 2.08 higher BMI. Moreover, when the BFP benefit represented a high percentage of the total household income, adolescent's weight for height were on average higher by 1.46, indicating that the benefit as a proportion of the income is having a short-term effect in development and growth of adolescents.

The vast majority of female adolescents were in the average weight status category and such an increase to the mean (WHZ equals 1.3 and BMI equals 21.3) and median (WHZ equals 1.3, and BMI equals 20.8) of weight status indicators, suggests low risk of individuals becoming obese in the short term. Similar to females, adolescent males were overwhelmingly in the average weight status category and the additional increase to the mean (WHZ equals 1.18 and BMI equals 20.4) or median (WHZ equals 1.18, and BMI equals 20.5) also indicates low risk of individuals becoming overweight or obese in the short term.

For adolescent males, BMI did not correlate with fat status as measured through sum of skinfolds, different from women and adolescent females. This pattern suggests that physical activity levels are higher among adolescent males, compared to females, or to adult women. Given this, I suggest that the increase in weight-for-height associated with a high proportion of income coming from the BFP benefit would contribute to improve the health status of adolescent males in the long run. My field observations are that obesity was not at all present among adult males, and although there were no statistical differences between genders for adolescents, adolescent males had lower indicators for weight status compared to females in all seasons (Table *75*).

The above observation requires further investigation, especially regarding gender and age differences associated with productive activities. For instance, in the Mamirauá Sustainable Reserve, adjacent to Amanã, (Silva et al. 2016) reported more than half of adult men and women between 18 and 59 years of age (exclusively obese percentage not reported), based on data collected in 2008. They report the highest rates of overweight and obesity in the literature among adult ribeirinhos, although likely lower than those of indigenous groups only including obese individuals, such as for the Suruí, where 12.2 % of men and 24.5% of adult women were obese (Lourenço et al. 2008).

One of the main differences between Mamirauá and Amanã is the type of ecosystem where they are located: while the first contains a floodplain, completely inundated for more than half of the year (Moura et al. 2016), the latter is characterized mostly by upland forested areas, frequently managed and used for agricultural production by its residents (Viana, Steward, and Richers 2016). One main factor mediating this difference would be the possibility of cultivating manioc fields throughout the year. For instance, Piperata, Ivanova, et al. (2011) argue that the major economic variable affecting dietary intake was the abandonment of manioc fields, associated with the BFP in communities of Caxiuanã.

In Amanã, overweight and obesity rates among adult females were yet greater than rates reported by (Silva et al. 2016), and teenage pregnancies were frequent, as observed in the communities studied and others nearby. These factors impose additional nutritional stress on females transitioning into adulthood. Anecdotally, in two households where the BFP benefit was controlled by mothers, adolescent females became pregnant during data collection. As previously mentioned, one of these adolescents only participated in one measurement in time, as she was too young to participate in the first effort (she was 11 years old) and got pregnant just after turning 12.

Results here are interpreted in light of three main theories. First, looking at a transition in diets, more specifically a replacement of non-industrially processed foods by highly processed ones , generally associated with women of low SES (Monteiro et al. 2004; Wells et al. 2012; Zeng et al. 2013). Second, the identification of a nutritional burden pattern, in which chronic malnutrition and obesity may occur concurrently in children and adolescents, or chronic malnutrition in children develops as a consequence in adulthood, including greater obesity risk (Tanner et al. 2014). Third, taking into account health risks associated with obesity, including cardiovascular diseases, cancer and type 2 diabetes (WHO 2000).

While no adolescent males or females were overweight or obese in Amanã (except for one measurement of one adolescent female, of the three recorded), between 32 and 38% of adult women were considered obese (using sum of skinfolds or BMI parameters respectively). When the type of BFP management in the household is considered, personal mother management was associated with a significantly increase in BMI as well as a higher proportion of Kilocalories consumed from highly industrialized foods for all individuals, independent of age group or gender (Table *83*).

The compounding evidence above suggests that, in the long run, the BFP associated with mothers' control over the benefit is contributing to an acceleration of adolescent females' health risks linked to obesity. This is considering that female adolescents have higher rates of intestinal infections by multiple parasites compared to male adolescents (Chapter 2). Moreover, based on the weight status of their mothers, in developing into adulthood, adolescent females have a higher probability of becoming obese compared to adolescent males. As reported in previous chapters, adolescent females at Amanã face a variety of stresses, and many work as caretakers of young siblings, sick, and elderly family members, including in households of friends and relatives. The story of Fabiane, mentioned in the Introduction section of this chapter, is the account of a participating adolescent about this issue. There are, however, adult women in the community who offer examples of successful professional development for adolescent females, especially teachers, but also health agents, and artisans.

Males are less commonly involved in the professions outlined above, and are usually responsible for production areas (as well as fishing and hunting), management of agricultural areas, or forests. Adolescent males have fewer examples of successful professions available to them that do not involve selling fish, farinha, or other crops. These are usually riskier economic activities, compared to being a teacher or health agent, for instance, given the unstable local economy and fluctuating prices of farinha, the main commercial product. However, many of the adolescent males work long hours in the fields with their parents and tend to perform physically demanding labor, such as clearing fields, harvesting manioc, and carrying heavy loads of the tuber long distances. One fitting example is the photovoice written by a 13-year-old boy who was unable to carry a sack of manioc, and had to request help from his older brother (Chapter 1). This pattern of physical activity counts as a benefit to heath considering their weight status.

BOLSA FAMÍLIA AT AMANÃ: THE NUTRITION TRANSITION AND OBESITY IN MOTHERS

As mentioned previously, mothers' control over the BFP benefit in the household has potential short term positive effects to the health status of male and female adolescents. However, compared to joint management, mother's control over the benefit may accelerate detrimental effects of the nutrition transition, especially for adolescent females in Amanã, as outlined above. More noticeable, is the significant association between women's control over the benefit in the household, and rates of obesity among women themselves. The evidence for adult women in Amanã shows the presence of a double burden for this group, in which almost half of participants presented signs of chronic malnutrition (47.1% stunted) and more than 30% had BMI under the obese category.

Unfortunately, from a global perspective the high rates exposed above are not surprising. The nutrition transition, characterized by major changes in diets and physical activity, has been linked to a rapid increase in obesity among adults, with fewer studies conducted on adolescents (Popkin and Gordon-Larsen 2004). Although the increase in rates of obesity worldwide were first associated with wealth, many researchers in past decades have shown its links to poverty, increasingly worrisome for adult women of low socioeconomic status (Popkin 2007; Monteiro, Conde, and Popkin 2007; Wells et al. 2012). Particularly in developing countries, including in Latin America, the nutrition transition entails a rapid dietary shift towards increased consumption of edible oils, sugar, and animal sourced foods since the 1990s. These dietary changes are concurrent with a shift away from physical activities demanding high energy expenditure, often linked to agriculture (Popkin and Gordon-Larsen 2004; Popkin 2007).

Indeed, further analysis of country-level data from 1975, 1989, and 2003, do show increases in higher overweight and obesity among the low income. Using the Brazilian national survey data, (Monteiro, Conde, and Popkin 2007) show that obesity significantly increased among the poor, accentuated among adult females (compared to males), and decreased among those with higher incomes. Indeed, the effect of gender is reflected on the national estimates. For all adults ages 20 and older, country level rates of obesity for Brazil have been reported as 15.5% for females, nearly double that of males (7.9%) (IBGE 2010). In a regional comparison, Batista Filho and Rissin (2003) have observed rising obesity rates among women from the Northeast of the country, historically a poor region, as is the North, and a decline in obesity for women living in the Southeast, arguably the most developed region of Brazil.

In the context of Amanã, women's personal management of direct cash transfers to families in extreme poverty, such as the BFP benefit, may be accelerating negative outcomes to their health, as delineated in the nutrition transition model. Findings from this study show that, when mothers exclusive control over expenditure of the BFP benefit within the household is associated with increased BMI and increased consumption of highly industrialized foods, compared to mothers living in household with joint BFP benefit management.

In accordance with results presented here, Piperata et al. (2011) did find evidence of increases in BMI for adult females associated with the BFP (although they observed lower rates of overweight and obesity – 19% of adult women), but the same was not found for both male and female adolescents, or even for adult males. The BFP has been characterized by men in Caxiuanã as "their wife's money" (Piperata et al. 2011), and the authors recognized the potential for household benefit management to interfere with perceptions and responsibilities for food provisioning, potentially explaining the observed abandonment of manioc fields and reduction in fishing and hunting activities, all commonly performed by men.

As outlined above, Piperata et al. (2011) show that the major economic variable affecting dietary intake was the abandonment of manioc fields, associated with the BFP, in communities of Caxiuanã. While *farinha* continued to be the most important source of carbohydrates, they report an increase in the consumption of purchased beans, rice, and crackers. They also show evidence of an increase in the reliance on frozen chicken, mortadella, canned beef, and sardines packed in oil.

As stated previously, the pattern of abandonment of agricultural fields was different in Amanã, where many households kept manioc fields. In terms of dietary changes, detailed data is provided in Chapter 2 of this dissertation, and the prevalence of certain items is much lower in Amanã compared to Caxiuanã, such as beans and rice. Moreover, during the year of data collection, I saw mortadella once in a community's party, in which one of the households was selling prepared sandwiches. I also observed consumption of canned fish once, when it was served as a snack during a school break. Consumption of highly industrialized foods, as previously described, included mostly breads, canned beef, sausages, cookies, and artificially flavored drinks (juice powder). These were significantly more present in the diets of mothers living in households where they controlled the management of the BFP benefit.

CONCLUSION

In this chapter I offer an anthropological approach to understanding the nutritional and health status of mothers and adolescents living in rural areas of the Amazon, bringing together the social context, as well as biological variables. I address the effects of the Bolsa Família

Program, taking into account the social dimensions of health, including household decisions and the ethnographic context of Amanã. This approach builds on previous chapters and incorporates recommendations put forth by researches analyzing similar issues in the Amazon, postulating a need for understanding the particularities of Amazonian groups in terms of how policies affect health locally. This is especially the case for household dynamics and consumption patterns, particularly those related to women (Lima 2010; Piperata, Spence, et al. 2011; Adams and Piperata 2014; Silva et al. 2016; Brondízio et al. 2016).

Findings from this research show that family cash transfers controlled exclusively by women in the household, particularly the BFP benefit, may not necessarily translate into an improved health status for these women and their adolescent children. Control over the cash benefit expenditure by women was associated with increased BMI among women and adolescents, as well as increased consumption of highly industrialized foods such as breads, canned meats, and sausages. While it could be argued that increased kilocalorie intake may translate into positive outcomes for adolescents in the short term, this is not the case for adult women. Moreover, in the long term, health risks linked to obesity are expected among adolescents, particularly for girls.

In the short term, the aforementioned increase puts adult women at a higher risk of obesity and diseases associated with it, in a context where access to health services and treatment are precarious, and obesity rates among participating adult women are high (37.9%) compared to regional (rural North 15.5%) and national data (16.9%). For adolescent males and females, this increase may be beneficial due to more securely available energy during adolescence, a demanding period of growth and development, and therefore could represent an opportunity for catch-up growth. Evidence of past shortage in the provision of energy for mothers and adolescents was observed considering the high rates of stunting (significantly higher among mothers compared to adolescents).

In the long term, I suggest adolescent females are mostly at risk of having detrimental effects to health given their routines and activities conducted mostly around the household (often in the presence of stagnant, contaminated water), which typically involve minimal physical activity. They seem to be at a greater risk of contamination by intestinal parasitic infections, as outlined in Chapter 2. For adolescent males, who in general engage in intense physical activity in production fields, as well as during hunting, fishing, and other sporadic jobs, the increase in weight status may be beneficial over the long run. Furthermore, although a change in the consumption of highly industrialized foods associated with mother's control over the BFP benefit in the household was observed, the evidence found here does not fully support an overall change to the structure of diets, still heavily based on the staples of fish and farinha (as explored in Chapters 2 and 4).

The interpretations above must be taken with note of caution, and are dependent on future developments in the region, especially as they relate to livelihoods in Amanã, linked to the economic and social context of the surrounding Sustainable Development Reserve. As previously mentioned, common wage labor available in rural areas are mostly filled by adult females, and males may resort exclusively to productive activities linked to management of natural resources and agriculture, with lower and less reliable returns. Factors such as environmental variables, access to markets, infrastructure, and services (school, health, sewage, etc.), job opportunities, and land availability and tenure are all intertwined with household decisions in the various contexts of the rural Amazon. These may accelerate or slow down possible detrimental consequences to health.

While the Bolsa Família benefit may be empowering mothers within the household, this empowerment may not translate into an improvement in health status for these women or for their children. However, imposing this task on mothers in a context of increased obesity patterns at the national level, and in a place of historical social marginalization and dietary vulnerability such as Amanã, seems unfair. This research shows that in the context of Amanã, obesity risks in adult women are accelerated by their exclusive control over the Bolsa Família benefit in the household, and that beneficial effects on adolescent health may be confined mostly to the short term. Although mothers did not specifically identify the management of the benefit as a burden for them, Chapter 3's findings show how they did convey a sense of prioritizing children's wants and needs, and purchases using the BFP benefit as a separate fund were often made with this assumption in mind.

CONCLUSION

In this dissertation, I focused my analysis on a specific location inside the rural Brazilian Amazon, the Amanã Sustainable Development Reserve. I observed and analyzed everyday practices within households, production fields, trips to town, soccer matches, childcare, cooking, and so forth. I brought my positionalities to bear, combined with those of women and adolescents living in Amanã. With this approach, I used the richness and fine-scale evidence from Amanã to examine the impact and understand the underlying processes of two overarching worldwide trends. First, the spread of conditional cash transfers (CCTs) to address fundamental problems of economic inequality and social inequality, here specifically focused on health outcomes; and second, the nutrition transition model, which predicts a shift in diets from locally sourced staples to increased reliance on industrially processed and ready-to-eat foods; in turn linked to a sedentary lifestyles and high rates of obesity.

Once I was able to build rapport in the communities studied and participate in everyday events, the testing of the research questions outlined in the introduction of this dissertation revealed important findings. For that I gathered a wide array of evidence, including demographic data, sources of income, and food production from an initial census survey; information about management of the BFP cash transfer in two rounds of interviews with women; anthropometric and dietary intake data throughout the year (dry, rainy, and transition seasons) with women and adolescents; data on intestinal parasitic infections; fingernail fragments for stable isotope analysis; as well as ethnographic data. Moreover, I used the photovoice method to meet with groups of adolescents on a monthly basis to understand their perceptions and participation in activities related to food production and consumption. I collected data with women living in households that did not participate in the BFP, but only via a household census, food frequency questionnaire, and fingernail fragments, all collected at one point in time during the dry season. This was due to limitations in time and financial resources, given that these households were dispersed throughout the Reserve.

I open Chapter 1 by describing the presence of the river in the lives of community members in Amanã. As a researcher, I recount a few of my interactions with the people in Amanã, after arriving and leaving by boat. I proceed through the uncomfortable moments being a privileged outsider, but also show vulnerabilities and later recognition as a friend by many of the women and adolescents. Once there, the answer to my research questions began to unfold in nuanced ways. As I arrived from the field and analyzed the vast array of data collected, two major contributions emerged, matching the two main research questions in the introduction. These are summarized in the next section. Considering the first main research question, I did find a correlation between types of BFP funds management and nutritional and health status of women and children. In Chapter 3, I provide some details about household dynamics examining the mechanisms behind decisions over BFP money usage. In regards to the second research question about how participation in the BFP affects women's diets, I show how the predictions of the nutritional transition model do not seem to be playing out in Amanã as has been described in other Amazonian contexts. I suggest that participation in the program is not linked to a shift in the structure of diets characterized by a substitution of local staples. In fact, results indicate that in the environmental and historical context of Amanã, considering the formation of the Reserve and the development of residents' identities in that context, the effects of a nutrition transition have decelerated, contrary to patterns observed in other areas of the rural Amazon.

KEY FINDINGS

The first major contributions of this research to the emerging anthropological scholarship on the effects of poverty alleviation policies in rural settings, specifically in the rural Amazon, is the understanding of the crucial role of mothers in household money management, and the outcomes for diets and health associated with it. Given that a nutrition transition is rapidly reaching the most remote areas of the Amazon, money management of a cash transfer directed to women with the purpose of benefiting children in the household becomes a significant challenge to mothers. While accepting their role as managers, mothers become protagonists who take into consideration all household members' requests and aspirations in a constant balancing of expenditures; perceiving expenditures as an evaluation of failure or accomplishment.

The BFP assumption that a cash benefit transferred to mothers in a household implies that a health improvement for all household members, especially children, does not hold entirely true for participants in this research. The data does suggest improvements for adolescents in the short term. For instance, there is evidence of a generational improvement in chronic malnutrition, with adolescents presenting significantly lower rates of stunting compared to their mothers. However, a causal relationship with the BFP is debatable. Moreover, mothers' exclusive control over the cash benefit as opposed to joint control, was associated with an increase in BMI for both adolescent males and females, which in the short-term may be interpreted as improving the availability of kilocalories in a context of instability linked to seasonality of food resources. Indeed, this increase in BMI would not necessarily translate into obesity among adolescents who are experiencing a period of growth and development and are overwhelmingly in the average BMI category.

On the other hand, the significant increase in BMI of mothers linked to their control over the BFP cash benefit may be interpreted as detrimental to their own health. Chapter 5 shows that more than 30% of the participating women were obese. Obesity levels for women at Amanã are approximately double the Brazilian average (17%), and more similar to the United States statistics (38.3%). Mothers' exclusive control over the BFP benefit, in contrast to joint management, was also significantly associated with an increase in the consumption of highly industrialized foods in the diets of mothers themselves, as well as for adolescent females and males. I argue that this association of mother's control over the BFP management and increased consumption of highly industrialized foods is ominous for adolescent females given their likely low physical activity patterns, as they are frequently responsible for household work. They may be at higher risks of contamination by intestinal parasitic infections (as shown in Chapter 2), and teenage pregnancy is also frequent (anecdotal data from fieldwork presented in Chapter 5).

Although we see an increase in BMI and in kilocalories from highly industrialized foods in diets of mothers and adolescents, linked to mothers control over the BFP benefit, there was no dietary shift per se. The dietary change in this case can be characterized as an addition of items and not necessarily a shift from locally sourced foods to highly industrialized items as described in the literature. Therefore, the argument here is that mother's exclusive control over the BFP expenditure is associated with addition of food items in their diets and in the diets of adolescents, and this is only partly in line with the nutrition transition model.

The second major contribution of this research sheds light onto the effects of participation in the BFP on predictions of the nutrition transition, particularly focusing on the diets of mothers in Amanã RDS. The hypotheses linked to this second research question were also built upon the predictions of the nutrition transition model and the regional literature. Several studies identified market integration or cash transfer policies as important drivers of change in land use and health of indigenous groups as well as of traditional populations in the rural Amazon (Coimbra Jr. et al. 2004; Godoy et al. 2005; Piperata et al. 2011; Nardoto et al. 2011). As discussed in Chapter 4, and in greater detail in Chapter 5, the most comparable studies to this one were conducted in the Caxiuanã National Forest (Piperata 2007; Piperata et al. 2011; Piperata, McSweeney, and Murrieta 2016). In their longitudinal research, Piperata, McSweeney, and Murrieta (2016) observe a decline in food security for rural populations living in Caxiuanã, and link these effects to BFP mechanisms. They document a decline in consumption of farinha, fish and açaí and an increase in consumption of industrially processed foods. Conversely, in Amanã, results indicate that mothers living in households participating in the BFP were not consuming locally sourced foods less frequently than non-participants. Furthermore, Piperata, McSweeney, and Murrieta (2016) show that a third of the families in their sample had discontinued the production of farinha and local dietary staples were substituted for purchased foods. In Amanã, the frequency of purchased foods in diets of mothers living in households participating and not participating in the BFP did not differ significantly. While these associations may be confounded by unbalanced samples due to differences in range of age, additional tests did not indicate a significant effect of age in consumption of foods purchased or locally sourced foods in women's diets.

In light of the regional literature on this manner, the evidence from this research raises a conundrum that is exposed throughout the pages of this dissertation: Why is it that residents of Amanã may be experiencing differential effects of the BFP when compared to other rural areas of the Amazon?

Here I offer some insights in responding to these questions, addressing possible methodological limitations and further research within the scope of this study. In Chapter 1, I describe some characteristics about the history of the creation of Amanã RDS likely playing a role in the distinction outlined above, especially considering the legacy of environmental conservation and the influx of social and economic support channeled through IDSM and other NGOs.

The evidence from Amanã suggests that the "economy of affection" is present as characterized in the literature: a sense of community support, particularly described by a network of food exchange that contributes to the food security of Amazonian households (Lima 1992; WinklerPrins and Oliveira 2010; Eloy and Emperaire 2011). When looking at frequency of foods received by other households in Amanã, no significant differences were detected in terms of participation in the BFP. Women's youth, however, was correlated with a more frequent consumption of foods received from other households, indicating that an economy of affection and assistance toward households perceived as food insecure are still present in Amanã. Among the women in households not participating in the program, which were in general younger than BFP-participants, this number was 21.1%. Limitations of these quantitative data comparing diets of BFP-participants and non-participants is are the unbalanced samples in terms of age range imposed by characteristics of BFP-participant and non-participant households in the area, and that the data collection is limited to food frequency questionnaires as opposed to 24-hour recalls, and therefore only frequency of consumption can be inferred. Based on dietary data calculations using kilocalorie contributions of food items from the weighed-inventory method (Gibson 2005), Piperata, McSweeney, and Murrieta (2016) suggest that the BFP conditionalities and cash infusion compromised this economy of affection at the community level in Caxiuanã, monetizing previous modes of social relations around labor. While this does not seem to be the case for Amanã, results regarding participation in the program and food exchange presented here are inconclusive due to the small sample size and differences in age amongst BFP participant and non-participant households. Findings do show that there is an important generational component linked to food exchange and the economy of affection.

BACKGROUND RESULTS

The ethnographic and detailed dietary data, mostly presented in Chapters 1 and 2, sets the background for historical and political developments, as well as a systematic analysis of mothers' and adolescents' diets addressing kilocalorie fluctuations and environmental seasonality. Findings from Chapter 2 are crucial for understanding the mechanisms through which broad scale effects, linked to CCTs and the nutrition transition, play out. Both Chapters 1 and 2 convey that the fish-farinha duo is at the core of diets for mothers and adolescents, with farinha being the main contributor of kilocalories, and fish the main contributor of protein on average. Farinha is completely integrated and tied to identity in Amanã, illustrated by some of the adolescents' photovoices presented in Chapter 1, as well as in the regional literature. In addition, vegetable oil is the most important source of fat, a key ingredient in adding variation to the preparation of locally sources foods, including in fried and stewed fish, as well as in foods derived from manioc other than farinha, such as fried manioc, manioc starch cookies, fried manioc dough, and manioc cakes (included as locally prepared foods – group 1- in Chapters 2 and 4).

However, a closer look at the contribution of core food items to diets of mothers and adolescents reveal fundamental generational differences. For instance, the proportion of farinha contributed to the total daily energy intake to mothers' diets is significantly greater compared to adolescents' diets. Conversely, the contribution of highly industrialized foods (e.g. cookies, ice pops, and sausages) is proportionally higher for adolescents, compared to mothers' diets. While these items contributed less than 4% of the average daily intake of mothers across seasons, they were among the top 4 kilocalorie contributors in the diets of adolescents, reaching 10.6% and 15.2% of the average daily kilocalorie intake in adolescent males' and females' diets respectively during the rainy season.

An important gender difference also emerged, with kilocalorie instability present in the diets of mothers and adolescent females, but not in the diets of adolescent males. For instance, while no statistical difference was observed in the kilocalorie contribution of prepared fish in adolescent males' diets across seasons, for adolescent females and mothers there was a significant decrease of 52% and 23% in the contribution of prepared fish to daily kilocalorie intake between the rainy and dry seasons respectively (4.3% and 4.2% of total energy intake). Additionally, more than 36% of adolescent females and almost half of adult women had intestinal infections from multiple parasites (48.6%). Infections by giardia were three times more common in adolescent females compared to adolescent males and adult women. Although at least one type of intestinal parasitic infections was detected for all participants, data on multiple infections, combined with findings from dietary analysis, show how adolescent females and mothers may be more vulnerable regarding their health status in the social, environmental, and cultural context of Amanã.

As expected, and despite the high variability in types of money management in the household, the cash transfer from the BFP program was predominantly separated (25 in 34 households), either as a fund specific for the purchase of a certain item, or as a fund managed by a specific member of the household. Surprisingly, once separated for a specific purpose, joint management of the BFP cash benefit was more common than personal women's management. Interviews indicate that mothers feel entitled to participate in the management of the BFP cash benefit in the household, although not necessarily with exclusive control over expenditure. When mothers do have exclusive control over the management of the BFP cash benefit, funds are linked to the purchase of items for children in the household, including foods desired by them as well as other consumer goods (e.g. electronics or furniture, frequently as rent-to-own). When the management of the cash benefit is done jointly by the nuclear couple, BFP funds are linked to the purchase of food exclusively, commonly the regular monthly purchase, which is not separated out or directed toward specific children. In addition, household income and its sources have significant effect on how the BFP funds are managed. The data suggests that when women secure other steady income for themselves, their participation in decisions around the benefit expenditure becomes less important for them. Also, whoever has the name printed on the debit card is more likely to control the expenditure.

FUTURE RESEARCH AND RECOMMENDATIONS

This dissertation examined the most important public policy program addressing poverty and children's nutrition in Brazil, and its interaction with household-level processes and local conditions. Conditional cash transfer programs such as the BFP studied here are spread throughout Latin America, and have expanded to Africa and Asia. While 16 countries had a CCT program implemented by 2008, in 2011 the number had almost doubled; even developed countries have implemented similar programs. In 2007 New York City launched a privately funded CCT pilot restricted to extremely poor neighborhoods: Opportunity NYC. The pilot finished in 2010 and was followed by the implementation of a similar program in areas of New York City and Memphis called Family Rewards. It is vexing that these programs have expanded without much supporting evidence, especially in terms of health outcomes for participants.

The results outlined in the above sections, as well as the conceptual framework provided in previous chapters, set up the basis for a larger study across the Amazonian region, also providing insights about its outcomes in other rural contexts. Future research in different contexts would benefit from including a focus on adult males' perceptions of money management and assessments of their diets and health status. In hindsight, despite the BFP being directed at women's roles in the household, I would like to have included adult males in the sample. This would probably require collaboration with another researcher, most likely himself male. Women's descriptions of household money management were key in understanding associations with health outcomes, and men's perceptions were not examined.

Moreover, the effects on diet and health of adult males were not evaluated here, and these seem to noticeably differ from that of adult females.

Specifically, for this research, analysis of stable isotope data from fingernail fragments may give more insight in understanding dietary differences between BFP participants and non-participants. Fingernail fragment data is considered a proxy for consumption of two important purchased items present in diets: sugar and animal protein from chicken or beef, representing a longer period of dietary intake (as opposed to a 24-hour recall).

In Amanã, two different stories seem to emerge depending on the scale of the analysis and methods entailed. When looking at individual level data from dietary intake and anthropometry among BFP participants, we see high rates of obesity among women, increased consumption of highly industrialized foods by mothers and adolescents associated with women's exclusive control over the BFP cash benefit, and a fluctuation in diets of adolescents with a large proportion of protein derived from highly industrialized foods. The individual level data indicates that *mother's exclusive control over the BFP benefit may accelerate the detrimental effects of the nutrition transition*, especially for adult women and adolescent females. This trend is consistent with the observed obesity rise among low income populations in the developing world, particularly prominent in adult women (Popkin 2007; Monteiro et al. 2007; Wells et al. 2012).

Turning to the household level data in terms of participation in the BFP, it seems that in the case of Amanã, *participation in the BFP is not associated with a substitution of local staples or changes in the structure of diets of adult women. A generational component may be more important in accounting for these changes*. Chapter 4 results show no statistical differences in consumption of local staples comparing diets of women in participating and non-participating households. Moreover, within BFP-participants there are indications of a generational component playing a role in the nutrition transition with male adolescents in particular consuming less manioc flour than their mothers (as a proportion of daily kilocalorie requirements), and a higher proportion of kilocalories coming from highly industrialized foods in adolescents' diets. Chapter 3 findings also show how mother's expenditure of the BFP benefit is permeated by adolescents' increased desires for a number of consumer goods, to which the BFP facilitated access to, including purchase of rent-to-own electronics, clothing and shoes, and industrialized foods.

Recommendations for the program, particularly considering a rural context in which land availability is not a marked limitation, such as in the Amanã RDS, could encompass incentives to practices related to improved health outcomes that would also benefit communities as a whole. For instance, in the case that unemployed adults reside in the household, men or women would receive incentives aiming to increase physical activity, while at the same time assisting in activities to benefit the whole community, such as working in food production for the school or maintaining community assets. One hypothesis is that this addition would spread the sense of responsibility to more members in the household while bringing more food resources from local production. Another hypothesis is that it would work to maintain the sense of community that already exists in many of these rural areas, especially if household members are contributing with work in organizations such as schools, health centers, and local associations.

The processes underlying individual and household decisions in Amanã is embedded in the history of its creation and identities formed, both in terms of taking pride in local activities of food production and environmental conservation. These are confronted by the contact with the urban environment, especially for the youth. While these influences do not have to be experienced in opposition, they become a real challenge especially for mothers making decisions on money expenditure. The photovoice accounts pose a clear evidence of the participation of adolescents in activities related to the local production of food, and their involvement with the community. However, many of their aspirations are linked to jobs and technologies mostly available in urban areas.

For instance, upon my return to the United States from Amanã, the best technology for keeping in touch with participants has been WhatsApp. Almost every week I receive news from someone who is in town and was able to secure an internet signal when passing in front of the state university or at the IDSM headquarters. These new technologies fill the aspirations of adolescents and young adults living in rural communities, and are also expressed in many well-liked songs. One of the most entertaining ones by Vavá Santos, has a refrain about a relationship that started on Facebook with a breakup through WhatsApp:

"No Facebook, book, book, a gente começou, no WhatsApp, zap, zap a gente terminou"

In the social and economic context of Amanã, initiatives that bring together possibilities of attaining the benefits of the urban and rural environment at the local level seem instrumental for maintaining a sense of community as well as local food production, with potential benefits for the health of all community members. Examples of these are: the presence of secondary schools in the reserve, providing the possibility for adolescents to complete their education while residing in these communities; the availability of jobs in schools and in research units of IDSM; and initiatives for introducing professional trainings (e.g. agriculture and computer science). Another front for supporting livelihoods based on the management of natural resources is related to the market of presently important products, such as farinha and fish, given price fluctuation and their difficulty in finding any credible buyers.

I built this research based upon the disheartening literature that describes a deterioration in the health of rural populations, including traditional and indigenous peoples in the Brazilian Amazon. The fact that a federal public policy designed to alleviate poverty and hunger may be part of the problem, facilitating diet and land use changes that accelerates obesity rates, is disconcerting. As exemplified in this research, broader social changes affecting the area are crucial for understanding the effects of the BFP on health. Moreover, the case of Amanã shows how anthropological methods are particularly valuable for understanding the process underlying individual and household decisions linked to the BFP. I am inspired by a recent call for anthropologists to lead applied research on this issue (Piperata, McSweeney, and Murrieta 2016) and I believe this research provides further insights on the problems and opportunities BFP may pose for improving the diet and health of rural Amazonians.

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APPENDIX: PHOTOVOICE METHODS

The photovoice project was adapted from Wang and Pies (2004) methodological approach to child health assessment in community participatory research. Essentially the photovoice method involves empowerment of marginalized populations by providing them with the means to photograph their daily activities, discuss their ideas with other community members, think critically about these activities, write narratives from their perspective, and finally to present them to an audience. Ideally this audience would be comprised of local leaders and decision makers, in order for them to act on a population's demands.

The objectives of the photovoice project go beyond the research questions of this study and were discussed by the group based on participatory concepts. The three main goals were: " (1) to enable people to record and reflect their community's strengths and concerns, (2) to promote critical dialogue and knowledge about important community issues through large and small group discussion of photographs, and (3) to reach policymakers" (Wang and Burris 1997, 370).

For this study, photography was conceived of as assistance to adolescents who have poor written literacy, while at the same time allowing for rapport to be built between them and the researcher. Moreover, adolescents would be able to analyze the meaning of an image produced by them, bringing up important themes they selected themselves. In this manner, they become active participants in research, without the spatial and temporal limits of traditional methods (Collier and Collier 1986, Barker and Weller 2003). Additionally, issues related to food production, preparation and consumption were often brought up by adolescents. This enabled them to provide data about their perspectives and participation in such activities, as well as on their diets.

This project involved 19 group meetings with adolescents above the age of 12, from July 2014 through January 2015 (Table 87). Each meeting lasted for 1 to 2 hours and, when possible, adolescents were divided into 2 or more groups and met at different times in order to facilitate dialogue and participation. Starting in October 2014 there were multiple one on one researcher-adolescent meetings in which we discussed ideas and follow up presentation of photovoices (photography coupled with a short narrative) created by each participant. The fundamental resources used by the researcher to guide every meeting and elaborate written materials were the concepts laid out by Wang and Burris (1997) and found in two manuals, “The PhotoVoice Manual” (Blackman and Fairey, 2008), and “A Photovoice Facilitator’s Manual” (Powers, Freedman and Pitner, 2012).

In the first meeting, all the adolescents and a research assistant from the community were invited. We then discussed what the project entailed, gave some examples of the process and results from other photovoice projects, and asked for informed consent. Next, we elucidated their expectations and fears about participating in the project, defined project norms and rules together, and outlined a tentative schedule. In the subsequent meetings we reviewed the main concepts, the norms and rules and added new themes (Table 87). The cameras were distributed to participants in the second meeting. There were 7 cameras available and each adolescent would use it during a week to photograph activities that they considered important for their lives and for the community. These were rotated so that everyone had a chance to photograph at least three times during project’s timeline. In November the group decided to rotate cameras more often, so once a participant had an idea of a narrative they would talk to the researcher or the research assistant (when the researcher was not present in the community) and request use of the camera. Adolescents were encouraged to participate in every single step of the project, including planning of meetings, recording ideas on a tablet, transferring data from cameras to a tablet, and so on.

All 27 adolescents participating in other research activities were involved in at least one of these meeting. Additionally, 8 adolescents older than 14 expressed interest in the project and were accepted to participate. Not all adolescents participated through the end of the project, due to reasons ranging from lack of interest in the project to lack of time available to participate to not being present during the time of the meeting, etc. Given that many families were travelling to other communities or towns in January and February 2015, some adolescents did not get a chance to participate in the final photovoice exhibits organized in the Santo Agostinho community or in the nearest town. There was a total of 18 adolescents who produced one or more photovoices for the final exhibit, of which 13 were between 12 and 14 years old, and were therefore also part of other research data collection.

Table 87. Summary of photovoice meeting data and of participants

Group Meeting	Date	Themes discussed (review refers to photovoice concepts and norms and rules)	Number of participants
1	7/30/2014	**Topic 1**: Photovoice concepts and examples, consents, expectations and fears, norms and rules, schedule	19
2	8/5/2014	**Topic 2:** Review, ethics and tips about photography, parts of a camera and how to use it, camera manual, camera disbursement (first time)	12
3	8/14/2014	**Topic 2:** Review, ethics and tips about photography, parts of a camera and how to use it, camera manual, camera disbursement (first time)	10
4	8/15/2014	**Topic 3:** Review, project responsibilities, identifying opportunities and problems in daily lives at the community, camera disbursement calendar, camera disbursement	14
5	9/12/2014	**Topic 4:** Review, discussion about difficulties encountered, dialogue about photographs selected, camera disbursement	12
6	9/19/2014	**Topic 4:** Review, discussion about difficulties encountered, dialogue about photographs selected, camera disbursement	8
7	9/30/2014	**Topic 5:** Review, tips about photography (part 2), practicing critical writing, writing using word (on a tablet), camera disbursement	4
8	10/2/2014	**Topic 5:** Review, tips about photography (part 2), practicing critical writing, writing using word (on a tablet), camera disbursement	14
9	10/6/2014	**Topic 6:** Review, presentation and discussion of selected photovoices, planning exhibit, camera disbursement	5
10	10/6/2014	**Topic 6:** Review, presentation and discussion of selected photovoices, planning exhibit, camera disbursement	4
11	10/6/2014	**Topic 6:** Review, presentation and discussion of selected photovoices, planning exhibit, camera disbursement	6
12	10/22/2014	**Topic 7:** Review, identifying themes in photovoices and discussing their importance, identifying new possible important themes, camera disbursement	14

13	10/23/2014	**Topic 7:** Review, identifying themes in photovoices and discussing their importance, identifying new possible important themes, camera disbursement	6
14	11/10/2014	**Topic 8:** Review, presentation and discussion of selected photovoices (part 2), planning exhibit (part 2), camera disbursement	7
15	11/15/2014	**Topic 8:** Review, presentation and discussion of selected photovoices (part 2), planning exhibit (part 2), camera disbursement	4
16	11/15/2014	**Topic 8:** Review, presentation and discussion of selected photovoices (part 2), planning exhibit (part 2), camera disbursement	3
17	11/15/2014	**Topic 8:** Review, presentation and discussion of selected photovoices (part 2), planning exhibit (part 2), camera disbursement	3
18	11/30/2014	**Topic 9:** Presentation and discussion of selected photovoices (part 2), planning exhibit (part 2), camera disbursement	9
19	1/12/2015	**Topic 10:** Finalizing photovoices and preparing for exhibit	8

APPENDIX 1: ADDITIONAL PHOTOVOICES

"This photograph shows a bunch of buriti on the ground, close to my house. My mom asked for the neighbor to get it, because he is tall, and helps us from time to time, and lives in the community next to here. It's difficult to harvest buriti because the its tree is very huge. To get this bunch it was necessary to climb a tree beside it. This day my mom made a very tasty juice for us to drink, and it was all gone fast. But buriti is also good to eat as a soft fruit, and to make popsicles, and ice pop with." (Jonathan's narrative for "The buriti" photovoice)

Figure A. Jonathan's photovoice: ""The *buriti*."

"We call these fishes Bodó. They are husky, and there are some which have ribs and others which don't. There are only three bodós without ribs in this picture. My neighbors were the ones who caught them. To eat them right away we hit their heads with the back of the machete and pull out the edges. To eat them on the next day, they have to stay in bowl of water, otherwise they die. If they die, then they are dead and are not worth for anything anymore. These ones in the photo died in the fire." (Sara's narrative for "The Ribless Bodó" photovoice)

Figure B. Sara's photovoice: "The Ribless Bodó."

"There are few people here who know how to make a canoe. In this photo a resident is making a canoe for someone. I think my dad bought his here, but it's a narrow one. When we go to my grandma's house, which is at the large river, we borrow a wider canoe from someone who lives here. There the waves are strong and can flood a canoe. Here the canoe is important not only to travel. My dad takes his go catch fish in the lake and bring them back to the community. It takes a narrow canoe to get to the fields, through the creeks behind the community, which will arrive at the outdoor kitchens [where manioc is processed into a flour]." (Sara's narrative for "Canoes" photovoice)

Figure C. Sara's photovoice: "Canoes."

"The day I took this picture I went with my mom to take a canoe to my brother who was fishing. On the way there was cauaçu and my mother took the opportunity to harvest the stalks to make crafts. It was a bit difficult because we had to go in the woods and it is risky to end up being bitten by a snake, or to get stung by a wasp, as they build their houses in the middle of the leaves. We had only brought one machete and my mom was the one cutting the cauaçu. I was then helping her to carry the bundles. "(Samuel's narrative for *"The Cauaçu"* photovoice)

Figure D. Samuel's photovoice: "The Cauaçu."

"Before, the school here was made of wood, then the number of students increased, and they made this one of cement, but it was not enough. In the morning, two classes are held in the accommodation for outside teachers, and students have to leave early, so the others [students from another class] can come in. I don't think this is right, and I think neither do the parents. There was a year here in which I studied in an old church, but when we want to learn, we confront any difficult that may come. One day I know I will depend on my studies" ("The school in our community" photovoice)

Figure E. Sandoval's photovoice: "The school in our community."

"My brother went fishing with our neighbor's son in the day of the election. They were fishing right in front on the community because pacus were swimming upstream. It was my brother who got all of these pacus. A bunch of people ate it. It was Election Day, but my dad had to stay here taking care of my sisters." (Sandro's narrative for "Grilled fish" photovoice)

Figure F. Sandro's photovoice: "Grilled fish."

"My brother and I were uprooting cassava. When we got there we started to pull the roots, then cut off the stems, and finally put in the sacks. When it was time to carry the sacks I was not strong enough to carry, and there was no way other than my brother carrying them by himself. He was very upset and when he got the last sack, he was very tired. I was very sad to see him so tired, and not be able to do anything: - Oh, yes I could! I could take a picture. (Sérgio's narrative for "No help" photovoice)

Figure G. Sérgio's photovoice: "No help."

APPENDIX 2: ANTHROPOMETRIC ANALYSIS AND RESULTS IN DETAIL

Growth status: long term nutrition

Height-for-age

The reference values used to calculate z-scores and the interpretation of such values for all measurements were made as recommended in WHO (1995). For the purposes of illustration and analysis, some categories were broken down in more detail, using the recommended cut-off point as a guide. The ranges used for the elaboration of graphs for height for age z-scores ranged from below -3.50 (short/stunted), -3.49 to -2.75 (short/stunted), -2.74 to -2.00 (short/stunted), -1.99 to -1.04 (below average), -1.03 to 0.00 (average), 0.01 to 1.03 (average), 1.04 to 1.64 (above average), and 1.65 to 2 (tall); these were chosen considering that there were a significant number of values in the short, below average and average ranges. The recommended cut-off value for stunting during adolescence is <3rd percentile, or < -2 Z-scores (WHO, 1995), which here would pertain to the last three bins. For weight for height, since values were highly concentrated in the average category, the ranges used were below -2 (wasted/low weight), -1.99 to -1.04 (below average), -1.03 to 0.00 (average), 0.01 to 0.51 (average), 0.52 to 1.03 (average), 1.04 to 1.64 (above average), 1.65 to 2 (heavy weight), and 2 to 3.1 (heavy weight). All maximum and minimum values for the z-scores were contained within the ranges used for each parameter.

The mean age for adult women was 37 and the mean height 1.51 cm and there was no difference in HAZ among different age groups for adult women (Table 88). For adolescent females, the mean age was 13.1, and the mean height 1.50 cm for all seasons combined; for adolescent males, values were 13.5 and 1.53 cm respectively. Table 89 shows the results by season.

Table 88. Female adult HAZ among different age groups

Age group (adults)	**Height female adults**		**HAZ female adults**		**P-value**
	M	*SD*	*M*	*SD*	
20-34 (N=16)	1.51	0.06	-1.83	0.89	0.61
35-65 (N=18)	1.49	0.05	-1.74	1.18	

Table 89. Age and height of adolescent females and males by season

	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
						Adolescent females						
		Rainy Season				*Dry Season*				*Transition Season*		
Age	12	14	12.7		12	14	13.1		12	15	13.5	
Height	1.41	1.57	1.48	0.06	1.43	1.58	1.51	0.06	1.44	1.58	1.51	0.05
						Adolescent males						
		Rainy Season				*Dry Season*				*Transition Season*		
Age	12	14	13.1		12	14	13.5		12	15	13.8	
Height	1.37	1.69	1.50	0.08	1.40	1.71	1.53	0.08	1.44	1.72	1.56	0.07

HAZ for adolescent females and males did not differ significantly (Figures 76,77,78) although on average adolescent females tended to peak at the below average categories and males on the average category. HAZ for adolescent females were not statistically different from adult females in any of the seasons, while HAZ for adolescent males appear different from adult females across seasons (p-value equals 0.05, 0.06 and 0.04 for the rainy, dry and transition seasons respectively).

Table 92. Growth status category summary for all age groups in population across seasons.

	Adult females		Adolescent females						Adolescent males					
Season	*Rainy*		*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Short/Stunted	16	47.1	2	20	2	18.2	3	27.3	3	20	3	21.4	2	16.7
Below average	11	32.4	5	50	5	45.5	3	27.3	5	33.3	5	35.7	4	33.3
Average	7	20.6	3	30	4	36.4	5	45.4	7	46.7	6	42.9	6	50
Above Average	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tall	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 91. Adolescents HAZ by gender for three data collection periods.

Age group	**HAZ (Data Point 1)**					**HAZ (Data Point 2)**					**HAZ (Data Point 3)**				
	Female (N=10)		*Male (N=15)*		*p*	*Female (N=11)*		*Male (N=14)*		*p*	*Female (N=11)*		*Male (N=12)*		*p*
	M	*SD*	*M*	*SD*		*M*	*SD*	*M*	*SD*		*M*	*SD*	*M*	*SD*	
12-14	-1.39	0.78	-1.22[a]	0.90	0.62	-1.20	0.77	-1.23	0.86	0.94	-1.38	0.76	-1.14[a]	0.88	0.50

[a] Adolescent males presented significantly higher HAZ scores compared to adult women (respectively p equals 0.05, 0.06 and 0.04)

Table 90. Female adult HAZ among different age groups.

Age group (adults)	**Height female adults**		**HAZ female adults**		**P-value**
	M	*SD*	*M*	*SD*	
20-34 (N=16)	1.51	0.06	-1.83	0.89	0.61
35-65 (N=18)	1.49	0.05	-1.74	1.18	

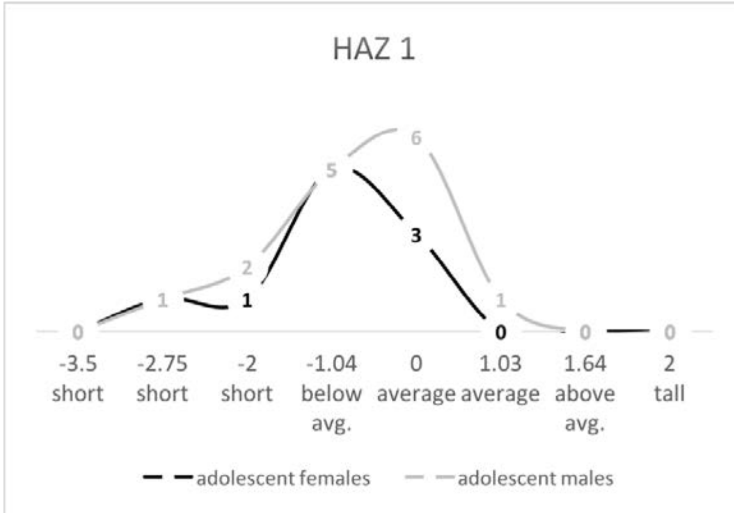


Figure 76. HAZ adolescent females and males, data point 1

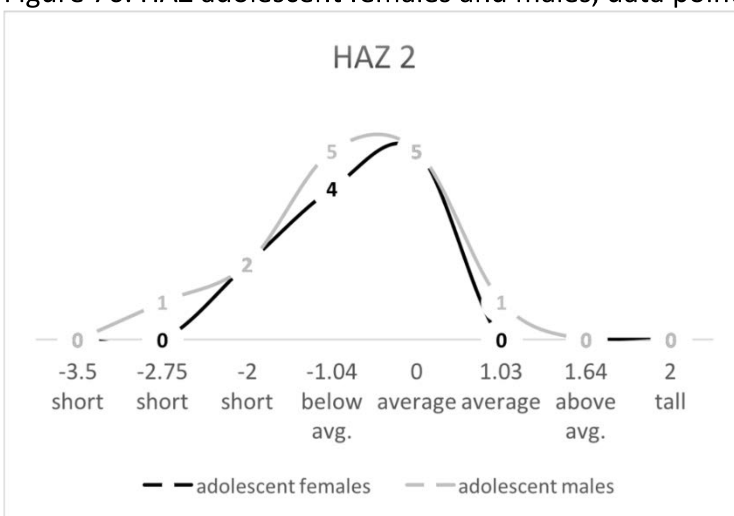


Figure 77. HAZ adolescent females and males, data point 2

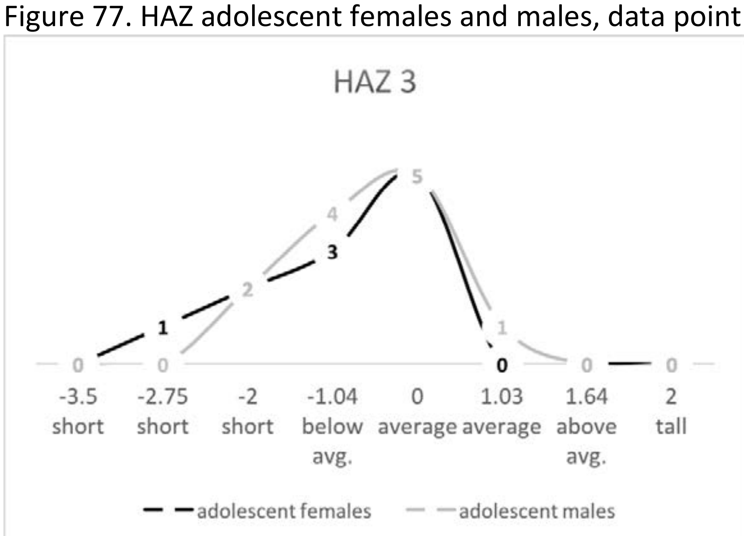


Figure 78. HAZ adolescent females and males, data point 3

Weight status: short term nutrition

Body Mass Index

From a practical point of view, BMI (Body Mass Index) values provide a good first approach for evaluating weight status. BMI for adults was calculated as the weight in kilograms divided by the square of height in meters; BMI for age was calculated for adolescent females and males according to charts developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (CDC, 2000). Adults were categorized according to BMI values as underweight, BMI lower than 18.5, average, BMI between 18.6 and 24.9, overweight, BMI between 25 and 29, and heavy weight, BMI equals or above 30 (WHO, 1995). Following the CDC guidelines for children and teenagers, BMI values below the 5th percentile were classified as underweight, 5th percentile up to 85th percentile as healthy weight, 5th to less than 95th percentile as overweight, and equal to or greater than the 95th percentile as heavy weight or obese.

For female adults, BMI values had moderate to high positive linear correlation with arm fat index z scores (AFIZ), with the coefficient correlation above 0.60 for all three measurements through time (Figures Appendix 2). However, for adolescent females, BMI was weakly correlated with AFIZ for the first and second measurements and moderately correlated for the last one (coefficient equals 0.37, 0.42 and 0.53 respectively). For adolescent males, BMI had a negative linear correlation with AFIZ for the first two data points and was weakly correlated in the last one (coefficient equals -0.06, -0.30, and 0.17). These correlations indicate that BMI may not be the most appropriate measures to evaluate adiposity for adolescent females and males.

The average BMI for female adults of different age groups was between 27 and 29 for all three measurements through time, and there were no significant differences between time of measurements or age group (Table 6). More than 60% of the adult women in this study had BMI values in the overweight or obese category across three data points (Table 94,Table 72). On the one hand, the percentage of female adults considered overweight (average 28.5%) in this population is lower than the national and north rural 2008-2009 estimates (respectively 48% and 47.4%); on the other hand, the percentage obese (average 33.8%) is a lot higher and in fact more than double the national and rural regional estimates of 16.9% and 15.5%

respectively, for all data points measured. Adolescent females and male BMIs were concentrated in the average category (Table 94), with categories very similar to the weight status as evaluated through weight for height

Table 93. Adult females BMI by age group across time.

Age group (adults)	BMI 1 (Rainy season)			BMI 2 (Dry season)			BMI 3 (Transition season)		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
20-34	27.6	6.04	0.89	27.3	6.3	0.69	27.9	6.14	0.77
35-65	27.9	4.67		28.1	4.62		28.5	4.68	

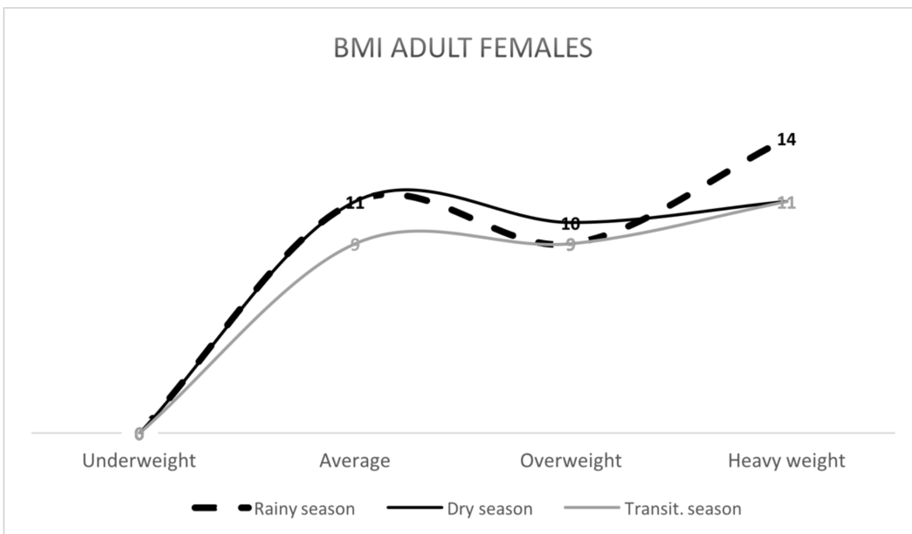
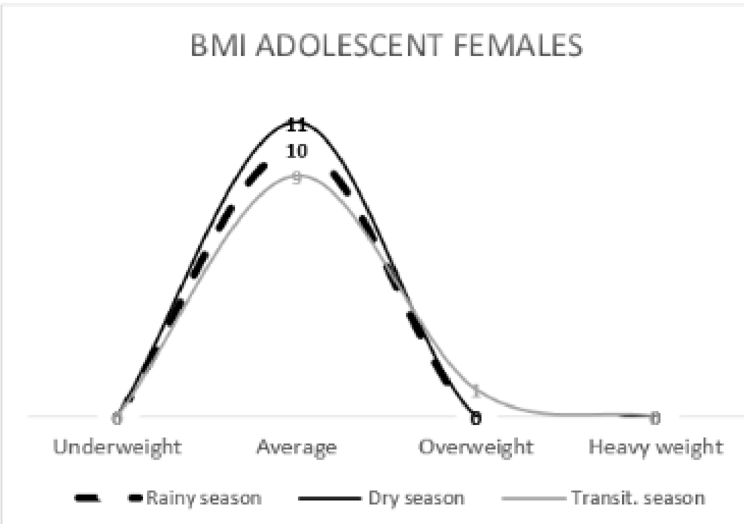


Figure 79. Adult females BMI across three data points

Weight for height measures are only appropriate for narrow age categories and BMI for age has not been validated as an indicator for adolescents and is less commonly used in the literature WHO (1995). Therefore, both indicators are presented here for adolescents. The values for BMI by age showed similar results as weight for height with most data points in the average category. Based on BMI values, one male adolescent was classified as underweight for all three measurements in time and one adolescent female was classified as overweight on one measurement in the transition season (Table 12). Differences between adult women and adolescents BMI are apparent: while adolescents present average BMI ranging from 18.6 to 19.4 (Table 95), adult females values range between 27 and 28.9 (Table 6).

Table 95. Weight status (BMI) category summary for all age groups in population across seasons.

BMI	Adult females						Adolescent females						Adolescent males					
Data Point	*1*		*2*		*3*		*1*		*2*		*3*		*1*		*2*		*3*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Underweight	0	0	0	0	0	0	0	0	0	0	0	0	1	7	1	7	1	8
Average	11	32	11	34	9	31	10	100	11	100	9	90	14	93	13	93	11	92
Overweight	9	26	10	31	9	31	0	0	0	0	1	10	0	0	0	0	0	0
Obese	14	41	11	34	11	38	0	0	0	0	0	0	0	0	0	0	0	0



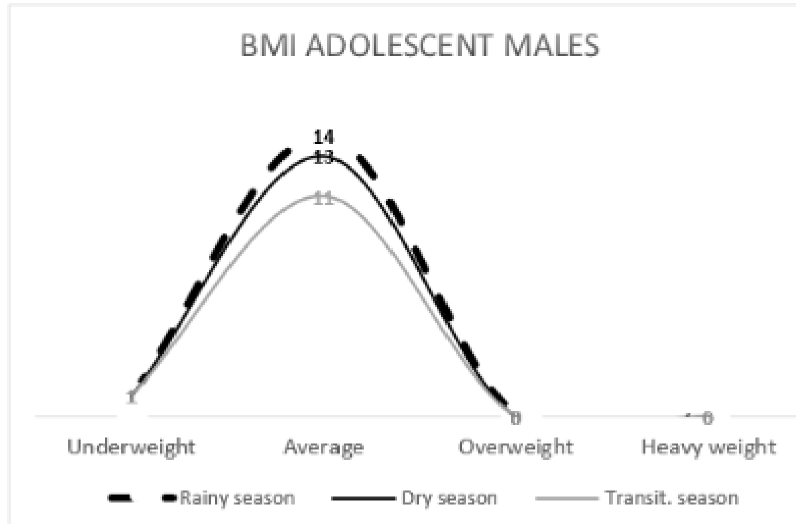


Table 94. Adolescents BMI for age by gender for three data collection periods

Age group	BMI (Data Point 1)				BMI (Data Point 2)				BMI (Data Point 3)			
	Female (N=10)		*Male (N=15)*		*Female (N=11)*		*Male (N=14)*		*Female (N=10)*		*Male (N=12)*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
12-15	18.6	1.7	18	1.4	19.3	2	18.3	1.6	19.8	1.9	18.8	2

Weight-for-height

There was no occurrence of wasting among adolescent females and adolescent males, and the vast majority of the subjects presented WHZ values in the average category (Table 4). All female adolescent participants had weight for height z-scores (WHZ) in the average category with a mean value of -0.06. The mean weight for female adolescents combining all seasons was 43.6 kilograms. For adolescent males, the mean weight for all seasons combined was 43.2 kilograms. All male adolescent except one (WHZ below average in the rainy season) had WHZ in the average category across seasons, with mean value equals to -0.25.

Table 96. Weight of adolescent females and males by season

	Min	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**
	Rainy Season				*Dry Season*				*Transition Season*			
Adolescent females												
Weight	33.4	50.1	41.2	6.21	35.2	55.3	44	7.2	38.4	56.9	45.5	6.17
Adolescent males												
Weight	30.1	55.4	40.7	7.03	31.1	57	42.8	7.34	34.3	59.1	45.9	7.98

Considering that weight-for-height is an indication of short term physical status, differences between seasons are expected to appear when there is variability in health status. However, there were no significant differences between measurements taken in different seasons for each group. For adolescent females *p* values were equal 0.27, 0.49 and 0.08 respectively comparing the three seasons, and for adolescent males values were 0.55, 0.90 and 0.69. There was also no difference between genders for adolescents (Table 5).

Table 97. Weight status (weight-for-height) for female and male adolescents across seasons.

Weight-for-Height	**Adolescent females**						**Adolescent males**					
Data points	*1*		*2*		*3*		*1*		*2*		*3*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Low weight	0	0	0	0	0	0	0	0	0	0	0	0
Below average	0	0	0	0	0	0	1	7	0	0	0	0
Average	10	100	11	100	11	100	14	93	14	100	11	100
Above average	0	0	0	0	0	0	0	0	0	0	0	0
Excess fat	0	0	0	0	0	0	0	0	0	0	0	0

Table 98. Adolescents WAZ by gender for three data collection periods

Age group	WHZ (Rainy season)					WHZ(Dry season)					WHZ (Transition season)				
	Female (N=10)		*Male (N=15)*		*P*	*Female (N=11)*		*Male (N=14)*		*P*	*Female (N=11)*		*Male (N=12)*		*P*
	M	*SD*	*M*	*SD*		*M*	*SD*	*M*	*SD*		*M*	*SD*	*M*	*SD*	
12-14	-0.24	0.29	-0.30	0.33	0.66	-0.05	0.47	-0.22	0.41	0.34	-0.05	0.45	-0.19	0.47	0.50

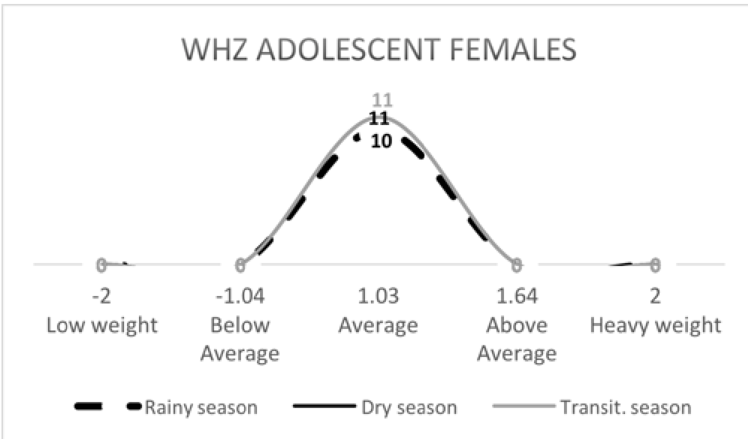


Figure 80. WAZ adolescent females across seasons

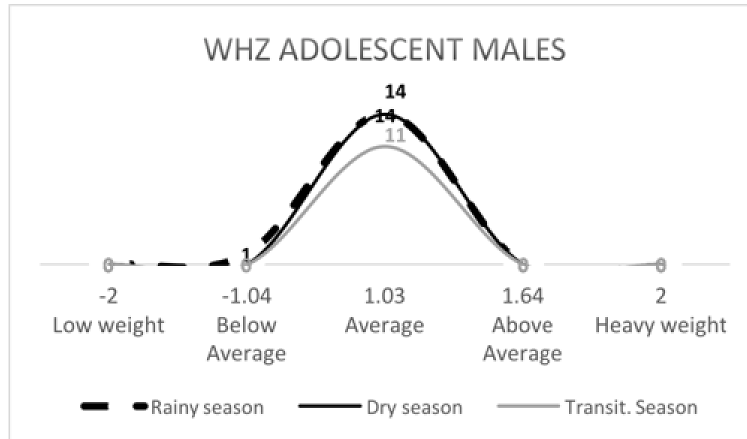


Figure 81. WAZ adolescent males across seasons

Muscle and Fat status

The analysis below focused on muscle and body fat, calculated using skinfolds. WHO (1995) recommends triceps skinfold and subscapular skinfold for age in adolescents as indicators, with cut-off values for obese as higher or equals 90th percentile (Z score > 1.645). Triceps skinfold and sum of skinfolds (triceps and subscapular) by height were also calculated for adolescents for the purpose of comparing results for potential differences, given the low stature of participants. The same cut-off (recommended by WHO, 1995) was used for all of the following results and discussion.

Upper-arm muscle area

Upper-arm muscle area (UMA) is calculated as a function of upper arm circumference and triceps skinfold [Upper arm circumference – (Triceps skinfold x π)]2/ (4 x π), in Frisancho, 1990]. UMA was calculated for male and female adolescents as a function of height and age, and for adults as a function of age. Low muscle status is associated with poor nutrition, and high muscle status can be somewhat associated with good nutrition, although physical activity plays an important role, especially in the context of very active populations as for most individuals in this case. Given that UMA is often overestimated for individuals considered obese, these were excluded for some of the analysis in this section. There were 15 adult females excluded, 10 of those participated in all three measurements and had BMI classified as obese for all data collection points. Of the remaining, 1 participated in one data collection point and was considered obese, 2 participated twice and were classified as obese once, and 2 participated three times and were classified as obese twice.

Including or excluding adult females classified as obese, according with the BMI calculations, all subjects were classified as average or above average, in terms of muscle status for all measurements through time, indicating adequate short term nutrition (Table 99). The average UMA for all female adults ranged from 37.2 to 40.6 and 40.7 respectively from data point 1 through 3; and excluding obese individuals, UMA values were 34.3, 38 and 38.3. The average UMA for adult females did not significantly differ by age, including or excluding obese individuals (Table 100 and Table 101).

Muscle mass status was different by seasons only for younger female adults, including or excluding obese individuals. The first ZUMA measurement was significantly lower than the second and third measurement including obese individuals ($p<0.02$ for both) and excluding obese individuals ($p<0.03$ and $p<0.06$ respectively). Obese individuals are often excluded because of overestimation, and the data corroborates, given that 60% of obese individuals presented above average or high ZUMA.

Table 99. Muscle status category summary for all age groups in population across seasons.

ZUMA	**All adult females**						**Adult females, excluding obese**					
Season	*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Low muscle	0	0	0	0	0	0	0	0	0	0	0	0
Below Average	0	0	0	0	0	0	0	0	0	0	0	0
Average	30	88	24	75	19	65	22	100	17	85	14	78
Above average	4	12	7	22	7	24	0	0	2	10	3	17
High Muscle	0	0	1	3	3	10	0	0	1	5	1	5

Table 100. Adult females ZUMA by age group across time including obese individuals.

Age group (adults)	**ZUMA 1**			**ZUMA 2**			**ZUMA 3**		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
19-34	0.26[a]	0.56	0.28	0.76	0.56	0.18	0.86	0.75	0.08
34-65	0.38	0.64		0.52	0.84		0.47	0.72	

[a] For younger adult females ZUMA was different between first and second measurements, and first and third ($p<0.02$ for both cases).

Table 101. Adult females ZUMA by age group across time excluding obese individuals.

Age group (adults)	**ZUMA 1**			**ZUMA 2**			**ZUMA 3**		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
19-34	0.15[a]	0.47	0.36	0.55	0.5	0.25	0.54[a]	0.65	0.29
34-65	0.07	0.54		0.31	1		0.35	0.80	

[a] For younger adult females ZUMA was different between first and second measurements ($p<0.03$), and first and third ($p<0.06$).

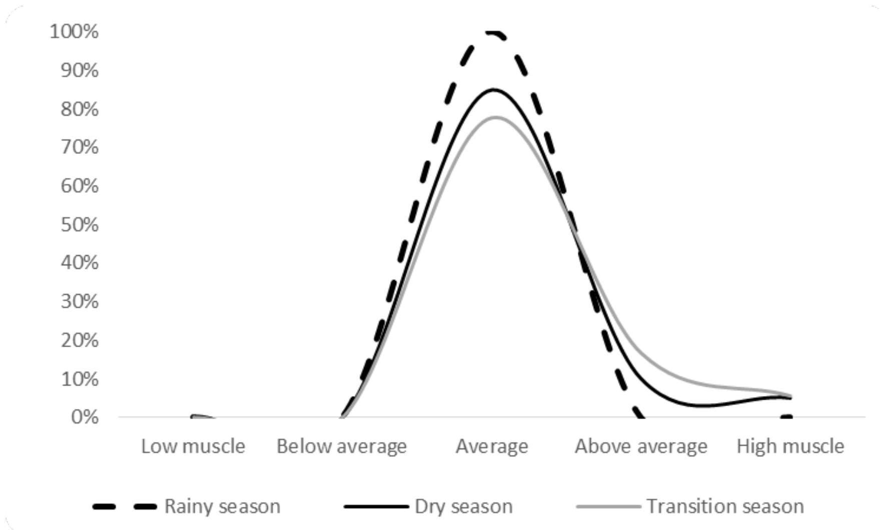


Figure 82. Percentage adult females ZUMA across three data points (excluding obese category).

When ZUMA is calculated based on height, adolescents figures also do not show poor nutritional status related to muscle status (Table 102), the majority of females and males were classified as average or above (100% for females, and at least 82% for males, considering all times of measurements); however 2 male adolescents (one for 2 data points, and one for one data point) were excluded, given that their height was not listed as a possibility for ages above 12 on the Frisancho reference tables.

When ZUMA is calculated by age, 3 adolescent males are classified as having low muscle mass (Comparing rainy and dry season, dry and transition, rainy and transition season, p-values were 0.11, 0.22, and 0.26 for females; and 0.41, 0.43, and 0.43 respectively for males.

Table 103), in 2 measurements for 1 adolescent male, and in 1 for 2 adolescent males. This is mostly a reflection of the relative lower weight of adolescents males compared to females (e.g. lower relative BMI in Table 95), and the large percentage of adolescents with short or below average stature for their age, as shown by analyzing HAZ (Table *69*). Even so, the majority (at least 78% of females, and almost 70% of all males across measurements) of the adolescents ZUMA-age values were in the average reference range. The 2 adolescent male outliers for ZUMA by height fell under the below average category calculated by age. There were no gender (Table 104) or seasonal differences in ZUMA-height or ZUMA-age (Table 105, and Figure 83, Figure 84, Figure 85 and Figure 86) for adolescents.

Table 102. ZUMA-height by gender for adolescents across seasons.

ZUMA-height	Adolescent females						Adolescent males					
Season	*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Low muscle	0	0	0	0	0	0	0	0	0	0	0	0
Below avg.	0	0	0	0	0	0	0	0	1	8	1	8
Average	7	70	9	82	8	80	11	79	9	69	7	58
Above avg.	1	10	2	18	1	10	1	7	2	15	3	25
High Muscle	2	20	0	0	1	10	2	14	1	8	1	8

Comparing rainy and dry season, dry and transition, rainy and transition season, p-values were 0.11, 0.22, and 0.26 for females; and 0.41, 0.43, and 0.43 respectively for males.

Table 103. ZUMA-age by gender for adolescents across seasons.

ZUMA-age	Adolescent females						Adolescent males					
Season	*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Low muscle	0	0	0	0	0	0	2	13	2	13	0	0
Below avg.	2	20	1	9	1	10	4	27	4	27	3	25
Average	7	70	10	91	9	90	9	60	9	60	9	75
Above avg.	1	10	0	0	0	0	0	0	0	0	0	0
High Muscle	0	0	0	0	0	0	0	0	0	0	0	0

Comparing rainy and dry season, dry and transition, rainy and transition season, p-values were 0.21, 0.42, and 0.26 for females; and 0.41, 0.41, and 0.34 respectively for males.

Table 104. Adolescent ZUMA-height by gender across time.

Adolescents	ZUMA rainy season			ZUMA dry season			ZUMA transition season		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
Females	0.8	1	0.2	0.4	0.6	0.3	0.6	0.6	0.5
Males	0.5	0.9		0.6	0.8		0.6	1	

Table 105. Adolescent ZUMA-age by gender across time.

Adolescents	ZUMA rainy season			ZUMA dry season			ZUMA transition season		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
Females	-0.2	0.9	0.15	-0.5	0.5	0.29	-0.5	0.4	0.39
Males	-0.6	0.8		-0.7	0.8		-0.5	0.7	

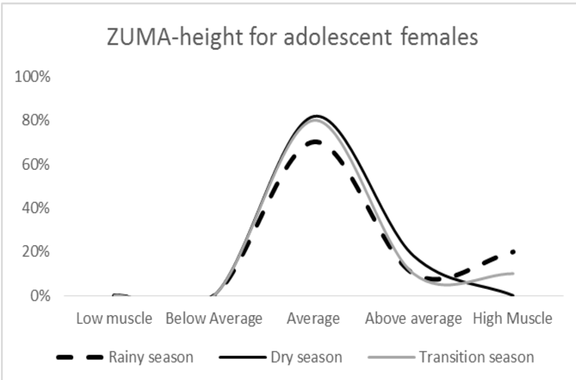


Figure 83. Adolescent females ZUMA-height across three data points (no significant differences).

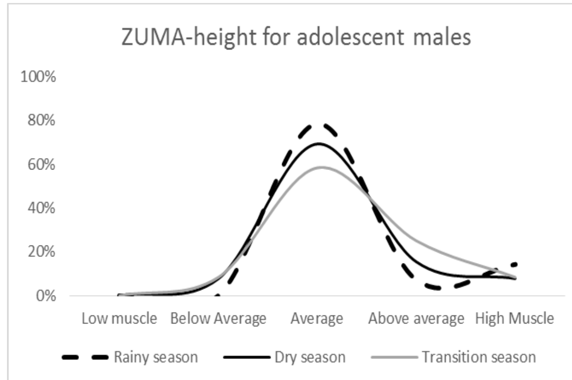


Figure 84. Adolescent males ZUMA-height across three data points (no significant differences).

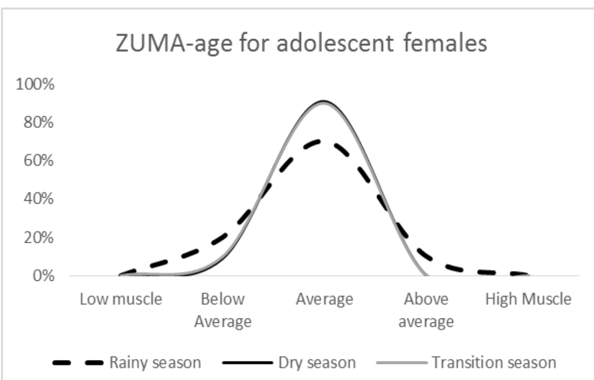


Figure 85. Adolescent females ZUMA-age across three data points (no significant differences).

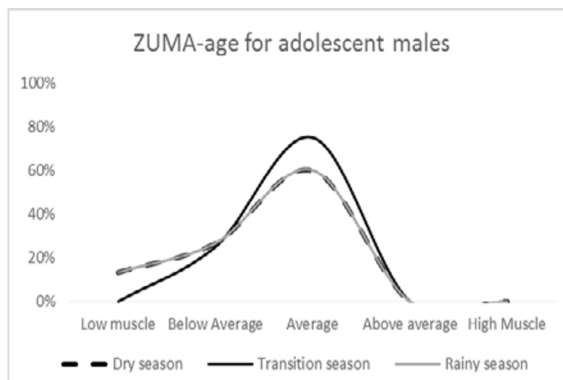


Figure 86. Adolescent males ZUMA-age across three data points (no significant differences).

Body Fat

Although BMI is often correlated with percent body fat, there are more direct estimates for the degree of adiposity, such as measurements of triceps and subscapular skinfolds. To increase the effectiveness of the fat status diagnosis for individuals, it is important to have multiple indicators such as sum of skinfold thickness and arm fat index (Frisancho, 1990); individuals whose z-scores fall below the 85.1 percentile, considering indicators such as triceps skinfold z-scores (ZTSF) and sum of skinfold (triceps and subscapular) z-scores (ZTSF+SSF) can then be considered to have fat levels associated with positive health (WHO, 1995). Here triceps skinfold, as well as the sum of triceps and subscapular skinfolds were used as estimates of body fat stores for adults and adolescents. The arm fat index (AFI) was also calculated as the Upper Arm Fat Area (Total Upper Arm Fat Area-Upper Arm Muscle Area) / Total Upper Arm Area (arm circumference squared divided by 4π) x 100 (Frisancho, 1990).

Including all participants and all seasons, Pearson correlation between ZAFI and BMI was equal to 0.72, and correlation between sum of skinfolds and BMI was 0.88; both considered high, indicating that BMI is a good indicator of body fat for this study. Considering only adult mothers these correlations were 0.88 and 0.60; for adolescent females 0.80 and 0.68; and for adolescent males 0.38 and -0.12 respectively. These numbers concur with the assumption that sum of skinfolds may represent a more robust measurement of fat status, given that it considers both subscapular and triceps measurements. The high correlation found between BMI and fat status measurements for adult mothers and adolescent females suggest BMI is a good indicator to be used in the analysis of health status; however, for adolescent males, correlation was low (for sum folds) and even negative (for arm fat index) suggesting BMI should not be used for this specific group. These results reflect the higher muscle mass in adolescent males, perhaps underestimated given calculations are done based on age. For adolescent females, weight-for-height highly moderately correlated with sum folds (0.61) and arm fat index (0.51). For adolescent males, correlation between weight-for-height and sum folds was again negligible (0.21) and negative with arm fat index (-0.14).

Given these results, BMI was used in the analysis section only for adult women and adolescent females, only sum of skinfolds was used as an indicator of fat status for adolescent males.

For adult females, indicators of fat status showed no difference between age group or across seasons for any of the indicators (Table 106, Table 107, Table 108) with the exception of ZAFI which was higher in the rainy season compared to the dry one ($p<0.04$). Considering BMI alone, 37.9% of the female adults were considered obese. The measurements of fat status based on skinfolds somewhat concur with those of BMI and show a trend of higher body fat in female adults, especially comparing to adolescents (Table 112, Table 113, Table 114). Combining all seasons, the percentage of adult females under the excess fat category were 31.6% using ZTSF+SSF, 29.5% using ZAFI, and 27.4% using only ZTSF. Overall, the minimum percentage of adult females combining the excess fat and above average categories were 36.8% (calculated using ZTSF) and maximum 45.3 % (calculated using ZTSF + SSF).

Table 106. Adult females ZTSF by age group across time.

Age/ ZTSF	**rainy season**			**dry season**			**transition season**		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
19-34	0.91	0.46	0.12	0.37	1.19	0.45	0.48	1.37	0.40
34-65	046	0.96		0.32	0.88		0.38	0.91	

Table 107. Adult females ZTSF+SSF by age group across time.

Age/ ZTSF+SSF	**rainy season**			**dry season**			**transition season**		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
19-34	0.82	1.08	0.22	0.39	1.01	0.42	0.57	1.18	0.44
34-65	0.55	089		0.45	0.87		0.62	0.88	

Table 108. Adult females ZAFI by age group across time.

Age/ZAFI	**rainy season**			**dry season**			**transition season**		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
19-34	0.98	1.05	0.09	0.31	0.86	0.41	0.37	0.44	0.42
34-65	0.54	0.09		0.38	0.89		0.44	0.90	

For adolescents, gender differences were not significant in terms of fat status, considering all indicators presented (Table 109, Table 110, Table 111). One exception was sum of skinfolds for the third measurement (transition season) in which the values for adolescent females were considerably higher (Table 110, $p<0.04$). There were no significant differences across seasons for adolescent females and males for ZTSF, ZTSF+SSF or ZAFI. For the three data points, female and male adolescents ZTSF, ZTSF+SSF and ZAFI were lower than those for adult females (P< 0.00 for all cases).

Table 109. Adolescents ZTSF by age across time.

Adolescent/ZTSF	**rainy season**			**dry season**			**transition season**		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
Females	-0.7	0.5	0.3	-0.4	0.7	0.4	-0.4	0.7	0.2
Males	-0.7	0.2		-0.6	0.3		-0.6	0.3	

Table 110. Adolescents ZTSF+SSF by age across time.

Adolescent/ ZTSF+SSF	**rainy season**			**dry season**			**transition season**		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
Females	-0.5	0.5	0.3	-0.3	0.7	0.3	-0.1	0.7	<0.04
Males	-0.7	0.2		-0.6	0.4		-0.6	0.3	

Table 111. Adolescents ZAFI across time.

Adolescent/ZAFI	**rainy season**			**dry season**			**transition season**		
	M	*SD*	*p*	*M*	*SD*	*p*	*M*	*SD*	*p*
Females	-0.7	0.7	0.4	-0.3	0.8	0.3	-0.3	0.9	0.1
Males	-0.7	0.7		-0.6	0.5		-0.6	0.4	

Table 113. Body fat measured as ZTSF by age, category summary for all age groups in population across seasons.

ZTSF	Adult females						Adolescent females						Adolescent males					
Season	*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Lean	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Below avg.	2	6	1	3	2	7	3	30	2	18	1	10	2	13	2	13	1	8
Average	16	47	21	66	18	62	7	70	8	73	7	70	13	87	13	87	11	92
Above avg.	6	18	1	3	2	7	0	0	1	9	1	10	0	0	0	0	0	0
Excess Fat	10	29	9	28	7	24	0	0	0	0	1	10	0	0	0	0	0	0

Table 112. Body fat measured as ZTSF+SSF by age, category summary for all age groups in population across seasons.

ZTSF+SSF	Adult females						Adolescent females						Adolescent males					
Season	*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Lean	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Below avg.	1	3	0	0	1	3	1	10	0	0	8	80	0	0	0	0	0	0
Average	13	38	22	69	15	52	9	90	10	91	1	10	15	100	15	100	12	100
Above avg.	9	26	1	3	3	10	0	0	1	9	1	10	0	0	0	0	0	0
Excess Fat	11	32	9	28	10	34	0	0	0	0	0	0	0	0	0	0	0	0

Table 114. Body fat measured as ZAFI, category summary for all age groups in population across seasons.

ZAFI	Adult females						Adolescent females						Adolescent males					
Season	*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*		*Rainy*		*Dry*		*Transition*	
	N	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*	*N*	*(%)*
Lean	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Below avg.	2	6	2	6	3	10	4	40	2	18	1	10	3	20	2	13	1	8
Average	13	38	19	59	16	55	6	60	7	64	7	70	12	80	13	87	11	92
Above avg.	5	15	4	13	3	10	0	0	2	18	1	10	0	0	0	0	0	0
Excess Fat	14	41	7	22	7	24	0	0	0	0	1	10	0	0	0	0	0	0

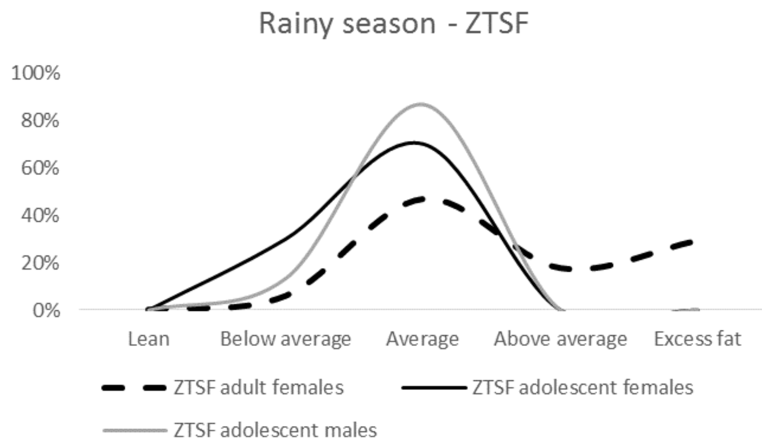


Figure 87. ZTSF for all age groups, data point 1.

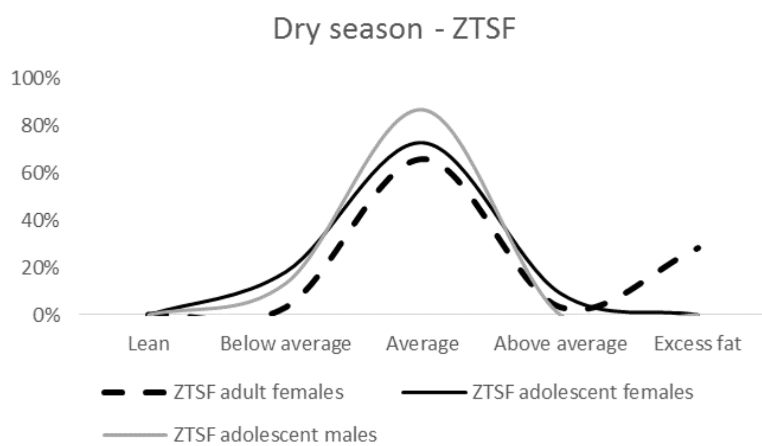


Figure 88. ZTSF for all age groups, data point 2.

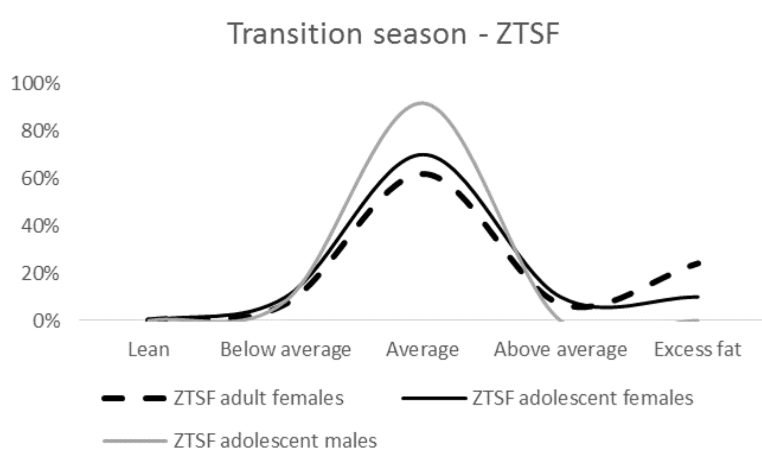


Figure 89. ZTSF for all age groups, data point 3.

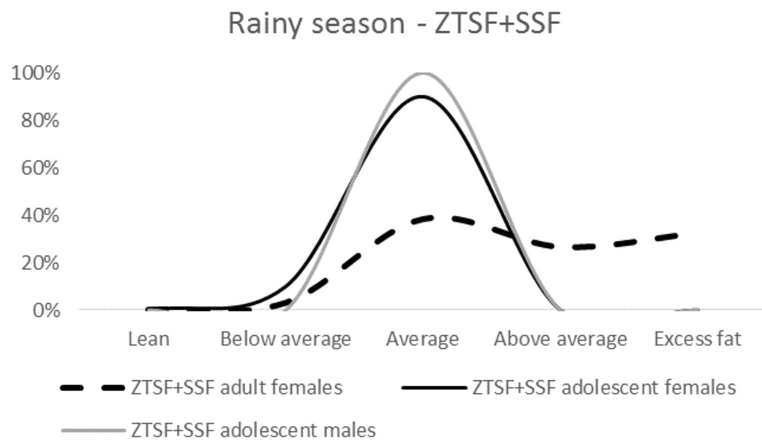


Figure 90. ZTSF+SSF for all age groups, data point 1.

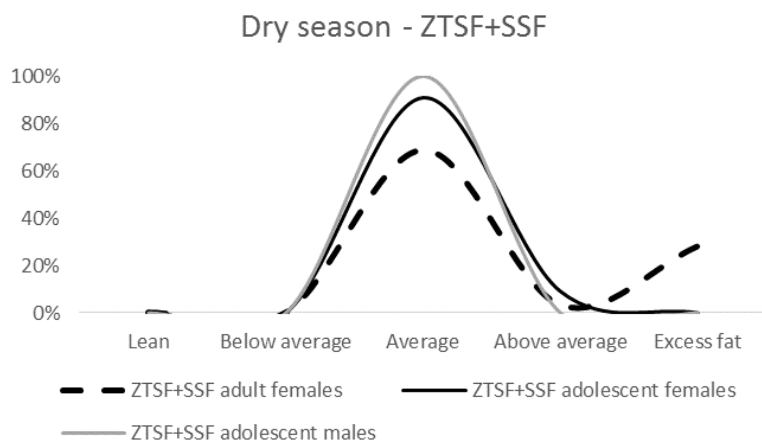


Figure 91. ZTSF+SSF for all age groups, data point 2.

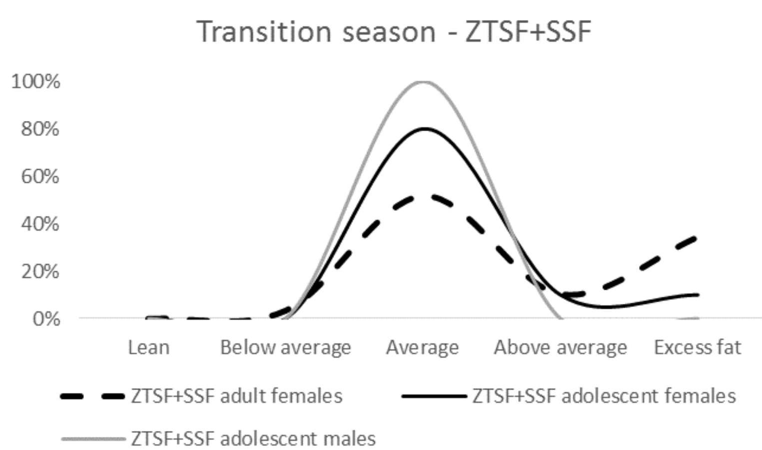


Figure 92. ZTSF+SSF for all age groups, data point 3.

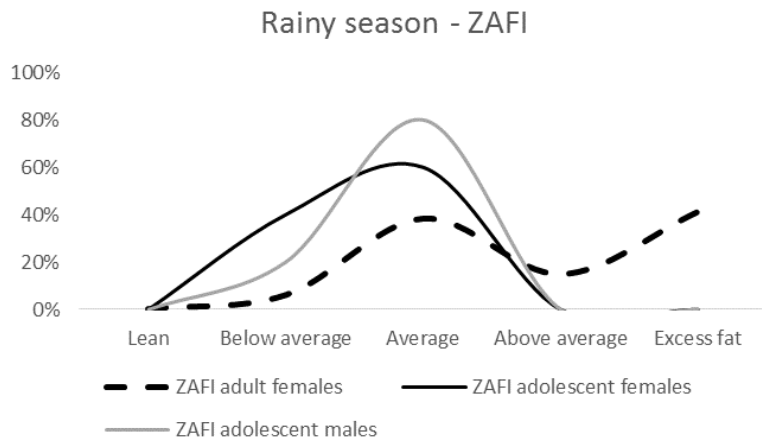


Figure 93. ZAFI for all age groups, data point 1.

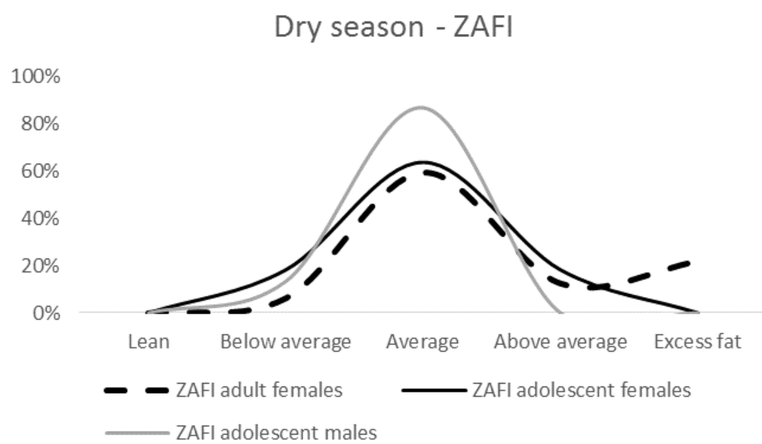


Figure 94. ZAFI for all age groups, data point 2.

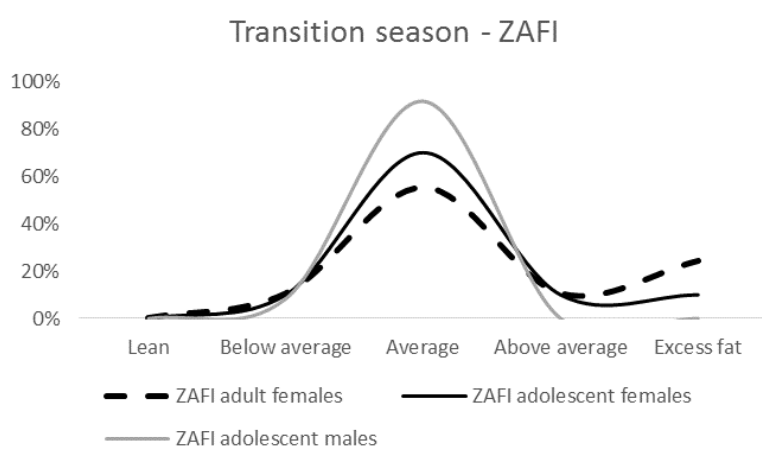
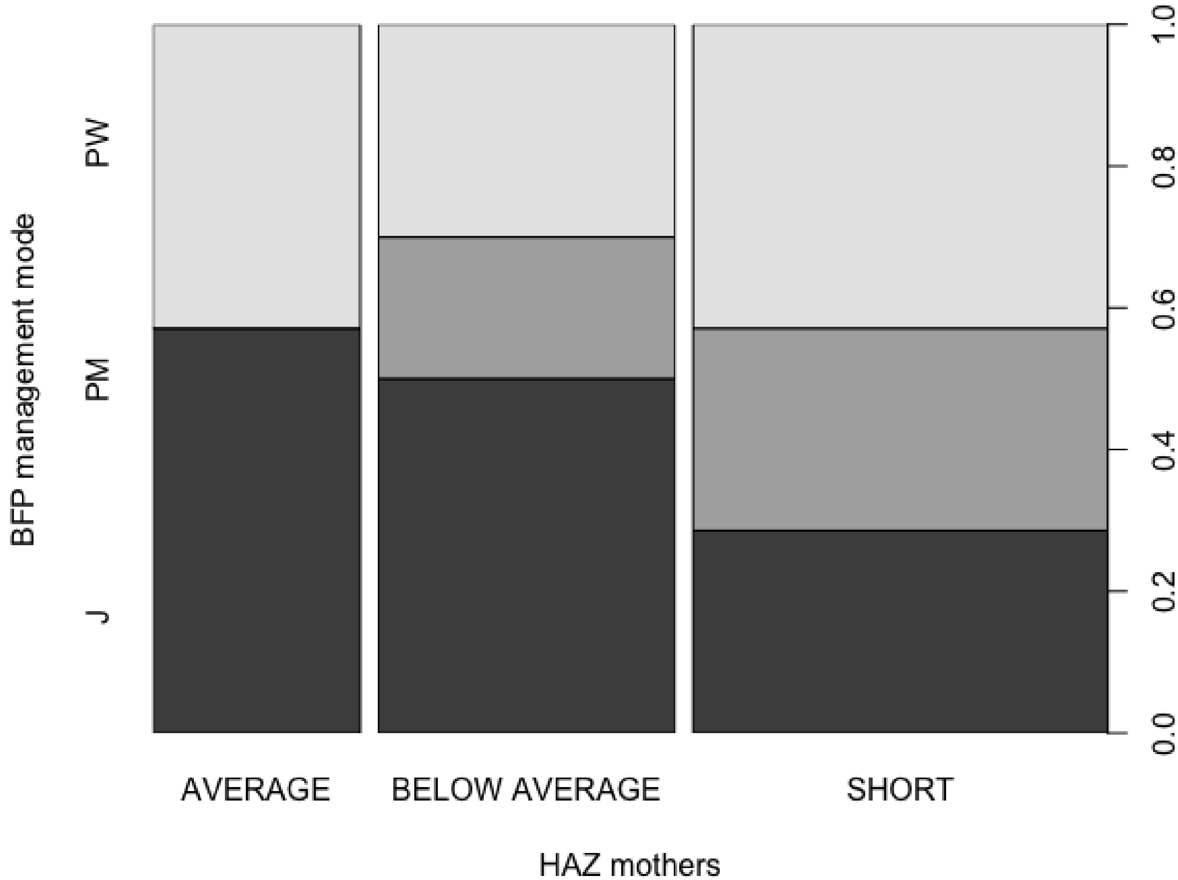
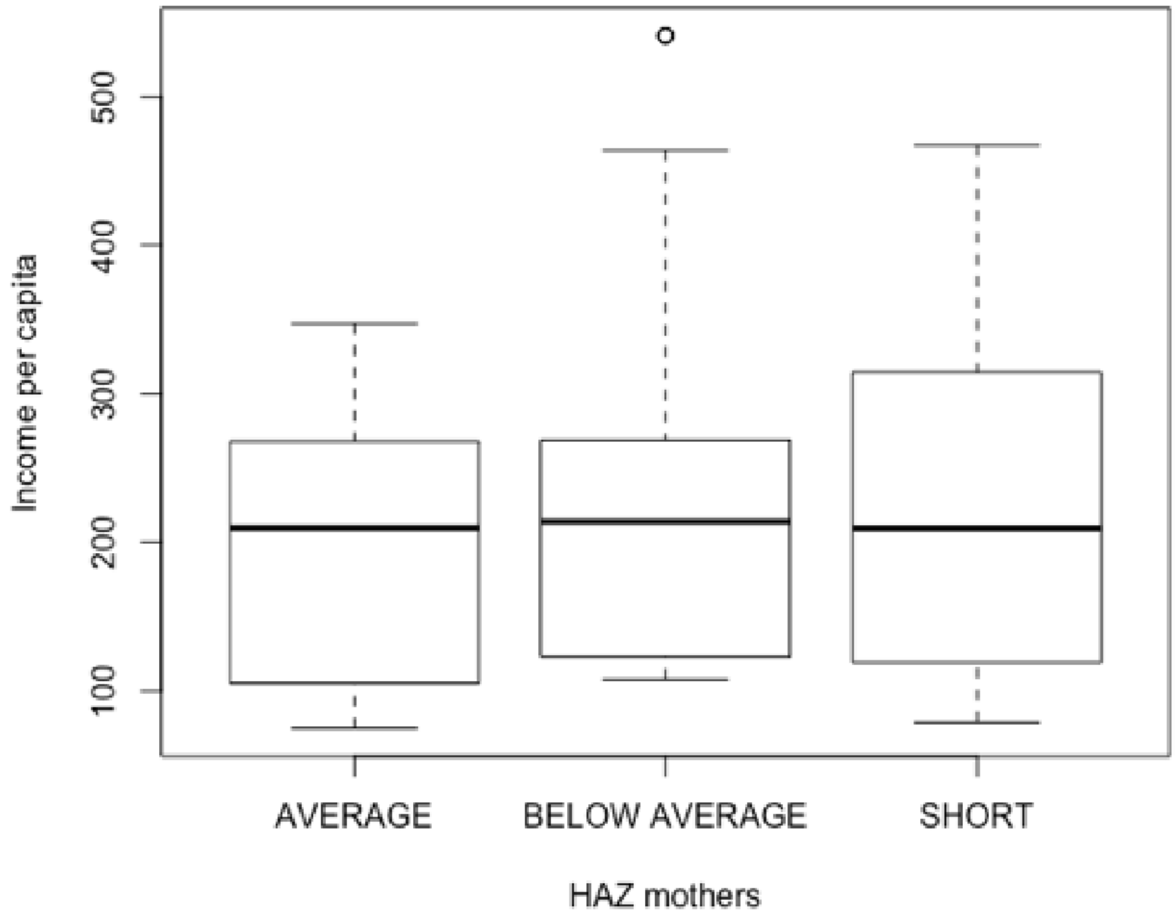


Figure 95. ZAFI for all age groups, data point 3.

APPENDIX 3: CHAPTER 3 FIGURES





500
400
300
200
100
Income per capita
AVERAGE
BELOW AVERAGE
SHORT
HAZ mothers

Appendix Chapter 2

R outputs for the Linear Mixed Model with recall data collected with women

Daily contribution of kilocalories by food type across seasons.

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + factor(food.type) + factor(season) *
factor(food.type) + (1 | id)
   Data: Fooditem_SUM_RNh

REML criterion at convergence: 2222

Scaled residuals:
    Min      1Q  Median      3Q     Max
-4.3143 -0.5066  0.0771  0.5621  3.5834

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.07595  0.2756
 Residual             1.01531  1.0076
Number of obs: 783, groups:  id, 18

Fixed effects:
                                                 Estimate Std. Error
df t value Pr(>|t|)
(Intercept)                                      5.135994   0.312246 682.1000
00  16.449  < 2e-16 ***
factor(season)2                                  0.830868   0.423203 714.2000
00   1.963 0.050001 .
factor(season)3                                  0.532140   0.432800 715.5000
00   1.230 0.219278
factor(food.type)beans                          -1.119536   0.592469 715.4000
00  -1.890 0.059214 .
factor(food.type)beef                           -0.080008   1.061108 715.5000
00  -0.075 0.939917
factor(food.type)chicken                        -0.739557   0.514345 714.0000
00  -1.438 0.150912
factor(food.type)cracker                        -0.375837   0.392814 715.4000
00  -0.957 0.339002
factor(food.type)dairy_mixture                  -0.855386   0.408995 715.3000
00  -2.091 0.036841 *
factor(food.type)eggs                           -0.432149   1.061030 714.6000
00  -0.407 0.683915
factor(food.type)Farinha                         1.037081   0.352368 712.9000
00   2.943 0.003354 **
factor(food.type)Fish                            0.008661   0.356905 713.1000
00   0.024 0.980647
factor(food.type)Fruits                         -1.510822   0.373897 713.3000
00  -4.041 5.91e-05 ***
factor(food.type)game                           -0.092879   0.779379 713.7000
00  -0.119 0.905173
factor(food.type)oiladded                       -0.363186   0.408359 714.0000
00  -0.889 0.374099
factor(food.type)otherG_0                       -0.673122   0.391919 714.0000
00  -1.718 0.086321 .
factor(food.type)otherG_1                       -0.570585   0.470822 713.7000
00  -1.212 0.225955
factor(food.type)otherG_2                       -2.560183   0.353796 713.0000
00  -7.236 1.19e-12 ***
```

```
factor(food.type)otherG_3                              -0.906728   0.423669 715.5000
00  -2.140 0.032678 *
factor(food.type)pasta                                 -0.620876   0.470296 713.1000
00  -1.320 0.187198
factor(food.type)rice                                  -0.035483   0.415365 714.3000
00  -0.085 0.931947
factor(food.type)Seasoning                             -1.286021   0.362115 713.1000
00  -3.551 0.000408 ***
factor(food.type)sugar                                 -0.756878   0.356668 712.6000
00  -2.122 0.034176 *
factor(season)2:factor(food.type)beans                  0.837824   0.833540 715.5000
00   1.005 0.315170
factor(season)2:factor(food.type)beef                  -1.275342   1.313513 714.8000
00  -0.971 0.331907
factor(season)2:factor(food.type)chicken               -1.971339   0.926378 710.9000
00  -2.128 0.033680 *
factor(season)3:factor(food.type)chicken                0.157989   1.179941 715.4000
00   0.134 0.893523
factor(season)2:factor(food.type)cracker               -0.655981   0.565276 715.2000
00  -1.160 0.246249
factor(season)3:factor(food.type)cracker               -0.299884   0.613202 714.7000
00  -0.489 0.624959
factor(season)2:factor(food.type)dairy_mixture  -0.978464   0.562786 714.2000
00  -1.739 0.082535 .
factor(season)3:factor(food.type)dairy_mixture  -0.646934   0.587538 713.6000
00  -1.101 0.271227
factor(season)2:factor(food.type)eggs                  -1.831823   1.248455 715.8000
00  -1.467 0.142741
factor(season)3:factor(food.type)eggs                   0.101426   1.501241 714.9000
00   0.068 0.946154
factor(season)2:factor(food.type)Farinha               -0.918308   0.494488 712.0000
00  -1.857 0.063711 .
factor(season)3:factor(food.type)Farinha               -0.740893   0.520183 711.9000
00  -1.424 0.154800
factor(season)2:factor(food.type)Fish                  -1.092384   0.499222 712.6000
00  -2.188 0.028981 *
factor(season)3:factor(food.type)Fish                  -0.925936   0.523293 712.0000
00  -1.769 0.077248 .
factor(season)2:factor(food.type)Fruits                -0.862582   0.541427 712.5000
00  -1.593 0.111567
factor(season)3:factor(food.type)Fruits                 0.064002   0.544964 713.0000
00   0.117 0.906543
factor(season)2:factor(food.type)game                  -0.870535   1.020259 715.5000
00  -0.853 0.393807
factor(season)3:factor(food.type)game                  -0.644318   1.105545 717.5000
00  -0.583 0.560207
factor(season)2:factor(food.type)oiladded              -0.427847   0.562001 712.4000
00  -0.761 0.446734
factor(season)3:factor(food.type)oiladded              -0.431250   0.622404 712.3000
00  -0.693 0.488612
factor(season)2:factor(food.type)otherG_0              -0.296422   0.563802 713.0000
00  -0.526 0.599222
factor(season)3:factor(food.type)otherG_0              -1.446481   0.582203 712.0000
00  -2.484 0.013202 *
factor(season)2:factor(food.type)otherG_1              -0.184762   0.632204 712.9000
00  -0.292 0.770180
factor(season)3:factor(food.type)otherG_1               0.552624   0.667537 714.8000
00   0.828 0.408029
factor(season)2:factor(food.type)otherG_2              -0.547792   0.494195 711.8000
00  -1.108 0.268040
factor(season)3:factor(food.type)otherG_2              -0.501855   0.518540 711.9000
00  -0.968 0.333462
factor(season)2:factor(food.type)otherG_3              -0.624078   0.573821 714.1000
00  -1.088 0.277146
```

```
factor(season)3:factor(food.type)otherG_3       -0.152132   0.620485 712.3000
00  -0.245 0.806386
factor(season)2:factor(food.type)pasta           0.003504   0.689971 711.5000
00   0.005 0.995950
factor(season)3:factor(food.type)pasta          -0.423364   1.166281 721.4000
00  -0.363 0.716708
factor(season)2:factor(food.type)rice           -0.963114   0.563904 713.2000
00  -1.708 0.088083 .
factor(season)3:factor(food.type)rice           -0.687961   0.592293 713.5000
00  -1.162 0.245819
factor(season)2:factor(food.type)Seasoning      -0.115262   0.512702 712.5000
00  -0.225 0.822190
factor(season)3:factor(food.type)Seasoning      -0.561308   0.529458 711.8000
00  -1.060 0.289433
factor(season)2:factor(food.type)sugar          -0.522468   0.498752 711.8000
00  -1.048 0.295201
factor(season)3:factor(food.type)sugar          -0.240670   0.523115 711.8000
00  -0.460 0.645606
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Daily contribution of protein from fish across seasons.

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_prot ~ factor(season) + height + (1 | id)
   Data: Prot_fish

REML criterion at convergence: 168.5

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.6356 -0.6296  0.1324  0.6874  2.4689

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.01174  0.1083
 Residual             0.51685  0.7189
Number of obs: 77, groups:  id, 18

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       0.8615     2.6589 16.6400   0.324   0.7500
factor(season)2  -0.2602     0.1895 60.7100  -1.374   0.1746
factor(season)3  -0.3596     0.2135 66.9000  -1.684   0.0968 .
height            1.7372     1.7330 16.7000   1.002   0.3305
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.020
factr(ssn)3  0.095  0.435
height      -0.999 -0.054 -0.126
```

Daily contribution of protein from other group 3 foods across seasons.

```
Linear mixed model fit by REML t-tests use Satterthwaite approximations to de
grees of freedom [lmerMod]
Formula: log_prot ~ factor(season) + height + (1 | id)
 Data: Prot_G3
```

```
REML criterion at convergence: 93.2
Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-1.7498 -0.5794  0.1193  0.4430  2.5707 
Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.0000   0.0000  
 Residual             0.8592   0.9269  
Number of obs: 37, groups:  id, 14
Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)  
(Intercept)      12.1041     6.0491 33.0000   2.001   0.0537 .
factor(season)2   0.1684     0.3549 33.0000   0.474   0.6383  
factor(season)3  -0.2108     0.4136 33.0000  -0.510   0.6137  
height           -6.8847     3.8911 33.0000  -1.769   0.0861 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.107              
factr(ssn)3 -0.181  0.499       
height      -0.999  0.074  0.152
```

Daily contribution of fat from vegetable oil added to dishes across seasons for mothers

```
Linear mixed model fit by REML t-tests use Satterthwaite
  approximations to degrees of freedom [lmerMod]
Formula: log_fat ~ factor(season) + (1 | id)
   Data: Fat_oiladded

REML criterion at convergence: 85.6

Scaled residuals: 
     Min       1Q   Median       3Q      Max 
-2.37979 -0.51518 -0.02412  0.70518  1.65695 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.08533  0.2921  
 Residual             0.47361  0.6882  
Number of obs: 38, groups:  id, 15

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)    
(Intercept)      2.61687    0.20749 28.86000  12.612 2.89e-13 ***
factor(season)2  0.44154    0.26228 31.41000   1.683    0.102    
factor(season)3 -0.02809    0.32582 34.43000  -0.086    0.932    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2
factr(ssn)2 -0.692       
factr(ssn)3 -0.568  0.445
```

Daily contribution of fat from fried bananas across seasons for mothers

```
Linear mixed model fit by REML t-tests use Satterthwaite
  approximations to degrees of freedom [lmerMod]
Formula: log_fat ~ factor(season) + (1 | id)
   Data: Fat_banana

REML criterion at convergence: 80.9
```

```
Scaled residuals:
     Min       1Q   Median       3Q      Max
-2.07868 -0.29630 -0.01447  0.69969  1.54808

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.04958  0.2227
 Residual             0.58396  0.7642
Number of obs: 34, groups:  id, 17

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       2.5197     0.2412 29.8120  10.445 1.77e-11 ***
factor(season)2   0.7882     0.3267 27.5210   2.413   0.0228 *
factor(season)3   0.4925     0.3348 28.8660   1.471   0.1522
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2
factr(ssn)2 -0.705
factr(ssn)3 -0.690  0.509
```

Daily contribution of fat from prepared fish across seasons for mothers

```
Linear mixed model fit by REML t-tests use Satterthwaite
  approximations to degrees of freedom [lmerMod]
Formula: log_fat ~ factor(season) + (1 | id)
   Data: Fat_Fish

REML criterion at convergence: 139.2

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.96256 -0.76409 -0.07817  0.57779  2.56286

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.01199  0.1095
 Residual             0.32602  0.5710
Number of obs: 77, groups:  id, 18

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       1.4477     0.1076 57.6100  13.453   <2e-16 ***
factor(season)2  -0.3103     0.1504 60.7700  -2.064   0.0433 *
factor(season)3  -0.2711     0.1687 67.8200  -1.607   0.1127
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2
factr(ssn)2 -0.673
factr(ssn)3 -0.603  0.433
```

Daily contribution of fat from highly industrialized foods (other G 3) across seasons for mothers

```
Linear mixed model fit by REML t-tests use Satterthwaite
  approximations to degrees of freedom [lmerMod]
Formula: log_fat ~ factor(season) + height + (1 | id)
   Data: Fat_otherG_3

REML criterion at convergence: 103.2
```

```
Scaled residuals:
    Min      1Q  Median      3Q     Max 
-1.2490 -0.6491 -0.1616  0.4183  2.6048 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1046   0.3235  
 Residual             1.0746   1.0366  
Number of obs: 37, groups:  id, 14

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)
(Intercept)      6.397855   7.466673 17.884000   0.857    0.403
factor(season)2  0.003019   0.404544 29.313000   0.007    0.994
factor(season)3 -0.037103   0.468955 27.751000  -0.079    0.938
height          -3.286511   4.810457 17.478000  -0.683    0.503

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.091              
factr(ssn)3 -0.177  0.498       
height      -0.999  0.060  0.151
```

Daily contribution of fat from mixed recipes (group 1 foods) across seasons for mothers

```
Linear mixed model fit by REML t-tests use Satterthwaite
  approximations to degrees of freedom [lmerMod]
Formula: log_fat ~ factor(season) + (1 | id)
   Data: Fat_otherG_1

REML criterion at convergence: 74.5

Scaled residuals:
    Min      1Q  Median      3Q     Max 
-1.8920 -0.5584  0.0087  0.6253  1.5705 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.4931   0.7022  
 Residual             0.6561   0.8100  
Number of obs: 27, groups:  id, 13

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)   
(Intercept)       1.1432     0.3762 22.4200   3.039  0.00595 **
factor(season)2   1.0416     0.4500 22.4780   2.315  0.03012 * 
factor(season)3   0.9521     0.4765 20.7680   1.998  0.05898 . 
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2
factr(ssn)2 -0.661       
factr(ssn)3 -0.587  0.460
```

Daily contribution of fat from crackers across seasons for mothers

```
Linear mixed model fit by REML t-tests use Satterthwaite
  approximations to degrees of freedom [lmerMod]
Formula: log_fat ~ factor(season) + (1 | id)
   Data: Fat_cracker

REML criterion at convergence: 31.2
```

```
Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.64567 -0.63612  0.00436  0.61883  2.08747

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.01178  0.1085
 Residual             0.10513  0.3242
Number of obs: 38, groups:  id, 15

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)
(Intercept)      1.91522    0.08493 29.75000  22.552   <2e-16 ***
factor(season)2  0.03178    0.12284 32.85000   0.259    0.797
factor(season)3  0.16983    0.14395 33.82000   1.180    0.246
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2
factr(ssn)2 -0.611
factr(ssn)3 -0.526  0.374
```

R outputs for the Linear Mixed Model with recall data collected with adolescent females

Daily contribution of kilocalories from selected food types across seasons for adolescent females

Manioc flour

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Farinha_F

REML criterion at convergence: 89.3

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.0288 -0.5492  0.1387  0.5108  1.7946

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1796   0.4238
 Residual             0.3226   0.5680
Number of obs: 47, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      11.1555     4.6564  8.5800   2.396   0.0415 *
factor(season)2  -0.1642     0.2041 36.9200  -0.804   0.4263
factor(season)3  -0.1355     0.2156 40.8300  -0.628   0.5332
height           -3.5254     3.1212  8.5200  -1.129   0.2895
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.045
factr(ssn)3  0.297  0.452
height      -0.999 -0.066 -0.317
```

Group 3 foods

```
Linear mixed model fit by REML t-tests use Satterthwaite approximations to
  degrees of freedom [lmerMod]
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: otherG_3_F

REML criterion at convergence: 61.4

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.1493 -0.2082  0.1169  0.6595  1.2256

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1358   0.3685
 Residual             0.8205   0.9058
Number of obs: 25, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      11.9657     6.8818 10.6030   1.739    0.111
factor(season)2  -0.7984     0.4658 19.2380  -1.714    0.103
factor(season)3  -0.3371     0.4762 20.1900  -0.708    0.487
height           -3.9662     4.5512 10.2020  -0.871    0.404

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.212
factr(ssn)3  0.127  0.477
height      -0.999  0.176 -0.162
```

Fried bananas

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Banana_F

REML criterion at convergence: 22.3

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.42064 -0.47937  0.07517  0.29133  1.34546

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.3678   0.6065
 Residual             0.4411   0.6642
Number of obs: 13, groups:  id, 7

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       3.5387    11.1585  7.1320   0.317  0.76023
factor(season)2   2.7552     0.5561  6.0730   4.954  0.00248 **
factor(season)3   2.6266     0.5991  8.3660   4.384  0.00210 **
height            0.1297     7.4951  6.9710   0.017  0.98668
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.276
factr(ssn)3  0.215  0.511
```

```
height       -0.999  0.245 -0.243
```

Prepared fish

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Fish_F

REML criterion at convergence: 71.4

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.4899 -0.4535  0.1025  0.4880  2.1547

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1896   0.4354
 Residual             0.2935   0.5418
Number of obs: 39, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       6.0174     4.7449  7.3120   1.268  0.24362
factor(season)2  -0.7382     0.2186 28.5640  -3.378  0.00213 **
factor(season)3  -0.6663     0.2422 31.3300  -2.751  0.00979 **
height           -0.3658     3.1817  7.2910  -0.115  0.91158
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.072
factr(ssn)3  0.257  0.551
height      -0.999 -0.098 -0.281
```

Fruits

```
 Linear mixed model fit by RE Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Fruit_F

REML criterion at convergence: 110.1

Scaled residuals:
     Min       1Q   Median       3Q      Max
-2.25582 -0.42047 -0.04587  0.67231  1.66785

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.7088   0.8419
 Residual             1.0547   1.0270
Number of obs: 37, groups:  id, 10

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)
(Intercept)     -6.66889    9.29081  8.55500  -0.718   0.4920
factor(season)2  0.01135    0.42200 26.38300   0.027   0.9787
factor(season)3  1.00432    0.43900 29.78800   2.288   0.0294 *
height           6.76360    6.22471  8.44800   1.087   0.3073
```

```
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.028
factr(ssn)3  0.301  0.425
height      -0.999 -0.049 -0.321
```

Crackers

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: cracker_F

REML criterion at convergence: 35.1

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.2989 -0.4221 -0.0177  0.3347  1.5288

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.2699   0.5195
 Residual             0.3063   0.5535
Number of obs: 20, groups:  id, 9

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      15.9207     7.1755  7.1490   2.219   0.0612 .
factor(season)2  -0.3425     0.3490 14.3100  -0.981   0.3427
factor(season)3  -0.3153     0.3582 14.0550  -0.880   0.3936
height           -7.2682     4.7794  7.0640  -1.521   0.1718
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.195
factr(ssn)3 -0.057  0.431
height      -0.999  0.176  0.039
```

Group 0 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: G_0_F

REML criterion at convergence: 52.2

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.8159 -0.4247  0.1426  0.6313  1.7450

Random effects:
 Groups   Name        Variance  Std.Dev.
 id       (Intercept) 1.196e-14 1.093e-07
 Residual             2.097e+00 1.448e+00
Number of obs: 18, groups:  id, 9

Fixed effects:
```

```
                 Estimate Std. Error      df t value Pr(>|t|)
(Intercept)        4.8702    10.5449 14.0000   0.462    0.651
factor(season)2    0.3367     0.9266 14.0000   0.363    0.722
factor(season)3   -0.2573     0.9459 14.0000  -0.272    0.790
height            -0.1239     7.0842 14.0000  -0.017    0.986

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.147
factr(ssn)3  0.228  0.655
height      -0.998 -0.201 -0.281
```

Vegetable oil added t dishes

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: oiladded_F

REML criterion at convergence: 40.3

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.3050 -0.6173 -0.3144  0.5801  1.7296

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1323   0.3637
 Residual             0.2639   0.5137
Number of obs: 25, groups:  id, 9

Fixed effects:
                 Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       14.9781     5.0136  5.7190   2.988  0.02586 *
factor(season)2    0.7637     0.2437 17.5460   3.134  0.00588 **
factor(season)3    0.8100     0.3138 17.6940   2.582  0.01899 *
height            -6.8629     3.3676  5.6930  -2.038  0.09024 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.016
factr(ssn)3  0.253  0.423
height      -0.999 -0.042 -0.271
```

Sugar

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: sugar_F

REML criterion at convergence: 95.2

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.0994 -0.5516 -0.1097  0.6862  2.4237

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.0574   0.2396
 Residual             0.4047   0.6362
```

```
Number of obs: 48, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       5.6119     3.5896  7.4300   1.563    0.159
factor(season)2  -0.1888     0.2226 37.3400  -0.848    0.402
factor(season)3  -0.2844     0.2342 40.6900  -1.215    0.232
height           -0.6915     2.4024  7.3600  -0.288    0.781

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.003
factr(ssn)3  0.212  0.464
height      -0.999 -0.027 -0.241
```

Group 1 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: G_1_F

REML criterion at convergence: 32.3

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.5603 -0.5706 -0.1470  0.8473  1.5482

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.000    0.0000
 Residual             0.755    0.8689
Number of obs: 16, groups:  id, 9

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      15.7259     6.9266 12.0000   2.270   0.0424 *
factor(season)2   0.5219     0.5446 12.0000   0.958   0.3569
factor(season)3   1.2057     0.5849 12.0000   2.061   0.0616 .
height           -7.2918     4.5743 12.0000  -1.594   0.1369
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.041
factr(ssn)3 -0.130  0.592
height      -0.998 -0.009  0.083
```

Group 2 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: G_2_F

REML criterion at convergence: 182.2

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.2251 -0.6288 -0.4684  0.7319  1.9707

Random effects:
```

```
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.4304   0.6561  
 Residual             4.0052   2.0013  
Number of obs: 45, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      -9.9421    11.1298  5.8900  -0.893    0.407
factor(season)2  -0.1535     0.7353 33.0000  -0.209    0.836
factor(season)3  -0.4414     0.7699 36.9100  -0.573    0.570
height            8.4747     7.4728  5.8900   1.134    0.301

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.009              
factr(ssn)3  0.252  0.488       
height      -0.999 -0.042 -0.284
```

Rice

```
Linear mixed model fit by REML t-tests use Satterthwaite approximations to
  degrees of freedom [lmerMod]
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: rice_F

REML criterion at convergence: 35.6

Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-1.7111 -0.2873  0.0629  0.4297  1.5946 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.3266   0.5715  
 Residual             0.1791   0.4232  
Number of obs: 24, groups:  id, 8

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)  
(Intercept)       0.2350     6.8235  7.2490   0.034   0.9735  
factor(season)2   0.4675     0.2363 16.1160   1.979   0.0652 .
factor(season)3   0.3737     0.2443 18.2280   1.530   0.1433  
height            2.8354     4.5341  7.1360   0.625   0.5512  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.105              
factr(ssn)3  0.388  0.523       
height      -0.999 -0.123 -0.404
```

Pasta

```
 Linear mixed model fit by REML t-tests use Satterthwaite approximations to
  degrees of freedom [lmerMod]
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: pasta_F

REML criterion at convergence: 18.3
```

```
Scaled residuals:
     Min       1Q   Median       3Q      Max 
-1.66454 -0.30056  0.06428  0.25949  1.13841 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.2780   0.5273  
 Residual             0.2456   0.4955  
Number of obs: 13, groups:  id, 8

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      -1.9534     8.0098  4.6050  -0.244    0.818
factor(season)2   0.3563     0.4277  7.6620   0.833    0.430
factor(season)3   0.6052     0.4466  5.3680   1.355    0.230
height            4.3658     5.3171  4.6370   0.821    0.452

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.082              
factr(ssn)3 -0.079  0.515       
height      -0.999 -0.118  0.051
```

Daily contribution of protein from selected food types across seasons for adolescent females

Prepared fish

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_prot ~ factor(season) + height + (1 | id)
   Data: Prot_Fish_AdoF

REML criterion at convergence: 71

Scaled residuals:
     Min       1Q   Median       3Q      Max 
-2.54291 -0.45321 -0.02514  0.53540  2.16061 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1731   0.4161  
 Residual             0.2948   0.5429  
Number of obs: 39, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)   
(Intercept)       4.2763     4.6066  7.2310   0.928  0.38320   
factor(season)2  -0.7242     0.2187 28.6470  -3.311  0.00252 **
factor(season)3  -0.6733     0.2420 31.3580  -2.782  0.00906 **
height           -0.2791     3.0888  7.2110  -0.090  0.93047   
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.069              
factr(ssn)3  0.251  0.551       
height      -0.999 -0.096 -0.276
```

Group 3 foods

```
Linear mixed model fit by REML t-tests use Satterthwaite approximations to
degrees
```

```
  of freedom [lmerMod]
Formula: log_prot ~ factor(season) + height + (1 | id)
   Data: Prot_G_3_AdoF

REML criterion at convergence: 67.6

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.5234 -0.7487  0.2549  0.6073  1.4441

Random effects:
 Groups   Name        Variance  Std.Dev.
 id       (Intercept) 1.484e-14 1.218e-07
 Residual             1.240e+00 1.114e+00
Number of obs: 25, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      -0.7457     7.1226 21.0000  -0.105    0.918
factor(season)2   0.1636     0.5557 21.0000   0.294    0.771
factor(season)3   0.5573     0.5613 21.0000   0.993    0.332
height            1.4749     4.6884 21.0000   0.315    0.756

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.266
factr(ssn)3  0.087  0.468
height      -0.998  0.228 -0.126
```

Daily contribution of fat from selected food types across seasons for adolescent females

Vegetable oil added to dishes

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: oiladded_Ff

REML criterion at convergence: 38.2

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.1797 -0.6022 -0.2850  0.5712  1.7495

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1172   0.3423
 Residual             0.2404   0.4903
Number of obs: 25, groups:  id, 9

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      12.4171     4.7468  5.6760   2.616  0.04193 *
factor(season)2   0.7200     0.2324 17.5620   3.098  0.00634 **
factor(season)3   0.7563     0.2992 17.7170   2.528  0.02121 *
height           -6.5510     3.1884  5.6500  -2.055  0.08860 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.016
```

```
factr(ssn)3  0.252  0.423
height      -0.999 -0.042 -0.271
```

Fried bananas

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Banana_Ff

REML criterion at convergence: 17.4

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.1101 -0.5944  0.1063  0.3905  1.0949

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.2785   0.5278
 Residual             0.2272   0.4767
Number of obs: 13, groups:  id, 7

Fixed effects:
                Estimate Std. Error     df t value Pr(>|t|)
(Intercept)       0.5133     8.8117 6.9420   0.058  0.95519
factor(season)2   2.3074     0.4056 5.8520   5.689  0.00139 **
factor(season)3   2.1678     0.4490 8.2590   4.829  0.00119 **
height            0.6532     5.9290 6.7900   0.110  0.91546
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.220
factr(ssn)3  0.268  0.513
height      -0.999  0.191 -0.294
```

Group 3 foods

```
Linear mixed model fit by REML t-tests use Satterthwaite approximations to de
grees of  freedom
 [lmerMod]
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: otherG_3_Ff

REML criterion at convergence: 73

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.72766 -0.81383  0.08686  0.78845  1.62591

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.000    0.000
 Residual             1.606    1.267
Number of obs: 25, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       4.5573     8.1057 21.0000   0.562    0.580
factor(season)2  -0.4273     0.6324 21.0000  -0.676    0.507
factor(season)3  -0.5904     0.6388 21.0000  -0.924    0.366
```

```
height              -1.5110     5.3355 21.0000  -0.283    0.780

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.266
factr(ssn)3  0.087  0.468
height      -0.998  0.228 -0.126
```

Crackers

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: cracker_Ff

REML criterion at convergence: 29.7

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.0467 -0.4311 -0.0586  0.3467  1.6364

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.2251   0.4744
 Residual             0.2059   0.4537
Number of obs: 20, groups:  id, 9

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      11.6932     6.2934  7.3110   1.858    0.104
factor(season)2  -0.3107     0.2904 13.7520  -1.070    0.303
factor(season)3  -0.3188     0.2979 13.7360  -1.070    0.303
height           -6.3385     4.1937  7.2230  -1.511    0.173

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.187
factr(ssn)3 -0.032  0.433
height      -0.999  0.170  0.015
```

Group 1 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: G_1_F

REML criterion at convergence: 32.6

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.51261 -0.46665 -0.02871  0.53749  1.04374

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.4434   0.6659
 Residual             0.4839   0.6956
Number of obs: 16, groups:  id, 9

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       8.6088     8.9102  6.0000   0.966   0.3713
factor(season)2   0.5910     0.4553  6.4440   1.298   0.2387
```

```
factor(season)3   1.7581     0.5903 11.7520   2.978   0.0118 *
height           -4.9052     5.9155  5.9050  -0.829   0.4392
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.020
factr(ssn)3 -0.051  0.511
height      -0.999 -0.054  0.017
```

R outputs for the Linear Mixed Model with recall data collected with adolescent males

Daily contribution of kilocalories from selected food types across seasons for adolescent males

Manioc flour

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Farinha_M

REML criterion at convergence: 91

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.90963 -0.59291  0.02884  0.61727  1.87526

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1068   0.3268
 Residual             0.1952   0.4418
Number of obs: 61, groups:  id, 15

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)
(Intercept)      5.52486    2.04348 12.75000   2.704 0.018323 *
factor(season)2 -0.08603    0.13266 50.93000  -0.649 0.519571
factor(season)3 -0.71515    0.18720 56.28000  -3.820 0.000335 ***
height           0.58408    1.36035 12.73000   0.429 0.674839
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.206
factr(ssn)3  0.437  0.364
height      -0.998 -0.232 -0.455
```

Group 3 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: G_3_M

REML criterion at convergence: 97.2

Scaled residuals:
```

```
    Min      1Q  Median      3Q     Max 
-2.6513 -0.3684  0.0725  0.5048  1.5986 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.2197   0.4687  
 Residual             0.7769   0.8814  
Number of obs: 37, groups:  id, 14

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       3.2783     3.9930 17.3570   0.821    0.423
factor(season)2   0.3339     0.3410 29.2350   0.979    0.335
factor(season)3   0.2699     0.4237 31.2080   0.637    0.529
height            1.3679     2.6482 16.9110   0.517    0.612

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.079              
factr(ssn)3  0.107  0.360       
height      -0.998  0.044 -0.136
```

Fried bananas

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Banana_M

REML criterion at convergence: 35.3

Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-1.0342 -0.5156 -0.2211  0.5136  1.0817 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.8014   0.8952  
 Residual             0.2440   0.4940  
Number of obs: 18, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       2.5666     7.2652  9.7240   0.353    0.731
factor(season)2   0.2765     0.5033  7.5240   0.549    0.599
factor(season)3  -1.0400     0.6329 10.9450  -1.643    0.129
height            2.3016     4.8607  9.9330   0.474    0.646

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.358              
factr(ssn)3  0.716  0.666       
height      -0.999 -0.373 -0.730
```

Prepared fish

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Fish_M
```

```
REML criterion at convergence: 131

Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-2.7344 -0.4301  0.1733  0.6875  1.9732 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.0000   0.0000  
 Residual             0.7319   0.8555  
Number of obs: 53, groups:  id, 15

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)  
(Intercept)      5.25888    2.35988 49.00000   2.228   0.0305 *
factor(season)2  0.03688    0.26295 49.00000   0.140   0.8890  
factor(season)3 -0.51382    0.35139 49.00000  -1.462   0.1501  
height          -0.06736    1.56494 49.00000  -0.043   0.9658  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.067              
factr(ssn)3  0.330  0.405       
height      -0.997 -0.121 -0.371
```

Fruits

```
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Fruit_M

REML criterion at convergence: 120.5

Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-1.7751 -0.7823 -0.1562  0.6867  2.0967 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.03262  0.1806  
 Residual             1.27016  1.1270  
Number of obs: 41, groups:  id, 15

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      -1.2651     4.2882 21.9300  -0.295    0.771
factor(season)2   0.2129     0.4407 33.3100   0.483    0.632
factor(season)3   0.1915     0.5202 36.8400   0.368    0.715
height            3.5448     2.8862 22.2800   1.228    0.232

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.309              
factr(ssn)3  0.447  0.443       
height      -0.998 -0.343 -0.477
```

Crackers

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: cracker_M

REML criterion at convergence: 56

Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-1.5612 -0.4189 -0.1627  0.5444  2.3120 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.06509  0.2551  
 Residual             0.28684  0.5356  
Number of obs: 33, groups:  id, 14

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)  
(Intercept)       4.3034     2.4378 13.6690   1.765   0.0998 .
factor(season)2  -0.5960     0.2295 28.4370  -2.597   0.0147 *
factor(season)3  -0.4756     0.2770 23.6390  -1.717   0.0991 .
height            0.8484     1.6243 13.6660   0.522   0.6098  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.165              
factr(ssn)3  0.359  0.421       
height      -0.998 -0.211 -0.392
```

Group 0 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: G_0_M

REML criterion at convergence: 79.9

Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-1.6867 -0.7812  0.1726  0.7724  1.4407 

Random effects:
 Groups   Name        Variance  Std.Dev. 
 id       (Intercept) 2.639e-13 5.137e-07
 Residual             4.052e+00 2.013e+00
Number of obs: 22, groups:  id, 12

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      -9.0224     8.6109 18.0000  -1.048    0.309
factor(season)2   0.9947     1.0717 18.0000   0.928    0.366
factor(season)3  -0.3358     1.2015 18.0000  -0.280    0.783
height            8.0536     5.6118 18.0000   1.435    0.168

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.017              
factr(ssn)3  0.419  0.271       
height      -0.998 -0.019 -0.452
```

Vegetable oil added to dishes

```
Linear mixed model fit by REML

t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: oiladded_M

REML criterion at convergence: 66.1

Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-2.5382 -0.4556  0.1940  0.6171  1.7937 

Random effects:
 Groups   Name        Variance  Std.Dev.
 id       (Intercept) 2.534e-15 5.034e-08
 Residual             6.777e-01 8.232e-01
Number of obs: 29, groups:  id, 11

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)  
(Intercept)       5.0674     3.0910 25.0000   1.639   0.1137  
factor(season)2   0.9839     0.4015 25.0000   2.451   0.0216 *
factor(season)3   0.3841     0.4660 25.0000   0.824   0.4176  
height           -0.2392     2.0793 25.0000  -0.115   0.9093  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.282              
factr(ssn)3  0.452  0.633       
height      -0.996 -0.352 -0.513
```

Sugar

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: sugar_M

REML criterion at convergence: 122.1

Scaled residuals: 
     Min       1Q   Median       3Q      Max 
-2.01124 -0.69327  0.02618  0.54045  2.68463 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.4585   0.6771  
 Residual             0.2776   0.5268  
Number of obs: 61, groups:  id, 15

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)  
(Intercept)       2.5276     3.6920 14.8200   0.685   0.5041  
factor(season)2  -0.3062     0.1647 53.0300  -1.859   0.0686 .
factor(season)3  -0.6271     0.2442 56.8300  -2.568   0.0129 *
height            1.4727     2.4583 14.8100   0.599   0.5582  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
```

```
             (Intr) fct()2 fct()3
factr(ssn)2  0.315
factr(ssn)3  0.549  0.407
height      -0.999 -0.332 -0.561
```

Group 2 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: G_2_M

REML criterion at convergence: 235.8

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.3945 -0.7943 -0.5336  0.9640  1.8926

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.04601  0.2145
 Residual             3.67088  1.9160
Number of obs: 59, groups:  id, 15

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       4.4848     5.1701 11.4200   0.867    0.404
factor(season)2   0.5233     0.5656 49.3200   0.925    0.359
factor(season)3   1.0518     0.7600 54.3500   1.384    0.172
height           -1.4907     3.4485 11.5200  -0.432    0.674

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.134
factr(ssn)3  0.377  0.403
height      -0.997 -0.183 -0.414
```

Rice

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: rice_M

REML criterion at convergence: 66

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.8073 -0.4628  0.1180  0.6200  1.2366

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1251   0.3537
 Residual             0.3243   0.5695
Number of obs: 35, groups:  id, 15

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       4.4786     2.7956 18.7400   1.602   0.1259
factor(season)2   0.4495     0.2426 28.9050   1.853   0.0741 .
factor(season)3   0.2369     0.2677 28.6020   0.885   0.3837
height            0.2542     1.8491 18.3830   0.137   0.8921
---
```

```
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
             (Intr) fct()2 fct()3
factr(ssn)2 -0.065              
factr(ssn)3  0.105  0.314       
height      -0.998  0.032 -0.133
```

Pasta

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: pasta_M

REML criterion at convergence: 26.8

Scaled residuals: 
     Min       1Q   Median       3Q      Max 
-0.96774 -0.42173  0.04194  0.43239  1.17010 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.6378   0.7986  
 Residual             0.1975   0.4445  
Number of obs: 15, groups:  id, 10

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)  
(Intercept)     -4.75168    6.58751  5.59600  -0.721   0.4997  
factor(season)2  0.00485    0.51129 10.96200   0.009   0.9926  
factor(season)3 -0.92801    0.46851  5.54100  -1.981   0.0989 .
height           6.70517    4.41553  5.62100   1.519   0.1830  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.132              
factr(ssn)3  0.065  0.584       
height      -0.998  0.096 -0.096
```

Group 1 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: G_1_M

REML criterion at convergence: 32.8

Scaled residuals: 
     Min       1Q   Median       3Q      Max 
-1.18518 -0.66628 -0.09638  0.47194  1.32208 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.1643   0.4053  
 Residual             0.4568   0.6759  
Number of obs: 17, groups:  id, 11

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      -0.5308     3.9876  2.0410  -0.133   0.9061
factor(season)2   0.2517     0.3905  5.7870   0.645   0.5439
```

```
factor(season)3  -1.0670     0.5720 12.1900  -1.865   0.0864 .
height            3.9242     2.6198  1.9260   1.498   0.2774
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.115
factr(ssn)3  0.328  0.454
height      -0.997 -0.170 -0.370
```

Daily contribution of protein from selected food types across seasons for adolescent males

Prepared fish

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_prot ~ factor(season) + height + (1 | id)
   Data: Prot_Fish_AdoM

REML criterion at convergence: 126.7

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.4215 -0.5471  0.1287  0.6341  2.0702

Random effects:
 Groups   Name        Variance  Std.Dev.
 id       (Intercept) 3.399e-16 1.844e-08
 Residual             6.704e-01 8.188e-01
Number of obs: 53, groups:  id, 15

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)
(Intercept)      3.69015    2.25862 49.00000   1.634    0.109
factor(season)2  0.02487    0.25166 49.00000   0.099    0.922
factor(season)3 -0.47028    0.33631 49.00000  -1.398    0.168
height          -0.09046    1.49779 49.00000  -0.060    0.952

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.067
factr(ssn)3  0.330  0.405
height      -0.997 -0.121 -0.371
```

Group 3 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_prot ~ factor(season) + height + (1 | id)
   Data: Prot_G_3_AdoM

REML criterion at convergence: 82.2

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.79323 -0.47849 -0.03551  0.60504  1.26399

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.4206   0.6486
```

```
 Residual             0.3749   0.6123
Number of obs: 37, groups:  id, 14

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)      -2.2223     3.9723 16.0670  -0.559 0.583562
factor(season)2   1.0200     0.2484 27.4990   4.107 0.000324 ***
factor(season)3   0.3038     0.3152 29.0880   0.964 0.343105
height            2.2000     2.6457 15.8550   0.832 0.418023
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.035
factr(ssn)3  0.205  0.396
height      -0.998 -0.060 -0.226
```

Daily contribution of fat from selected food types across seasons for adolescent males

Vegetable oil added to dishes

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: oiladded_Mf

REML criterion at convergence: 62.5

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.4618 -0.4682  0.1854  0.6435  1.8389

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.0000   0.0000
 Residual             0.5861   0.7656
Number of obs: 29, groups:  id, 11

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       3.0478     2.8745 25.0000   1.060   0.2992
factor(season)2   0.9389     0.3734 25.0000   2.515   0.0187 *
factor(season)3   0.3836     0.4334 25.0000   0.885   0.3845
height           -0.2927     1.9336 25.0000  -0.151   0.8809
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.282
factr(ssn)3  0.452  0.633
height      -0.996 -0.352 -0.513

Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Banana_Mf
```

```
REML criterion at convergence: 32.5

Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-1.0518 -0.5513 -0.2052  0.5397  1.1194 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.6136   0.7833  
 Residual             0.2107   0.4590  
Number of obs: 18, groups:  id, 10

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)
(Intercept)       0.4045     6.4771  9.7980   0.062    0.951
factor(season)2   0.3130     0.4643  7.7080   0.674    0.520
factor(season)3  -0.9315     0.5790 11.0840  -1.609    0.136
height            1.9527     4.3357 10.0130   0.450    0.662

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.366              
factr(ssn)3  0.716  0.665       
height      -0.999 -0.381 -0.731
```

Group 3 foods

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: G_3_Mf

REML criterion at convergence: 93

Scaled residuals: 
     Min       1Q   Median       3Q      Max 
-1.63434 -0.66308 -0.09251  0.57075  1.85806 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.4139   0.6433  
 Residual             0.5780   0.7602  
Number of obs: 37, groups:  id, 14

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)  
(Intercept)      0.486758   4.289099 14.052000   0.113    0.911  
factor(season)2  0.605846   0.303262 26.816000   1.998    0.056 .
factor(season)3 -0.002901   0.382127 28.852000  -0.008    0.994  
height           0.638376   2.853043 13.775000   0.224    0.826  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2 -0.008              
factr(ssn)3  0.168  0.382       
height      -0.998 -0.021 -0.192
```

Crackers

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
```

```
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: cracker_Mf

REML criterion at convergence: 50.8

Scaled residuals: 
    Min      1Q  Median      3Q     Max 
-1.5991 -0.3697 -0.1811  0.5557  2.4295 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.05454  0.2335  
 Residual             0.24011  0.4900  
Number of obs: 33, groups:  id, 14

Fixed effects:
                Estimate Std. Error      df t value Pr(>|t|)  
(Intercept)       1.4813     2.2308 12.8300   0.664    0.518  
factor(season)2  -0.5563     0.2100 28.3680  -2.649    0.013 *
factor(season)3  -0.4000     0.2534 23.1110  -1.578    0.128  
height            0.7939     1.4864 12.8260   0.534    0.602  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.165              
factr(ssn)3  0.359  0.421       
height      -0.998 -0.211 -0.392
```

Prepared fish

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: log_cal ~ factor(season) + height + (1 | id)
   Data: Fish_Mf

REML criterion at convergence: 101.2

Scaled residuals: 
     Min       1Q   Median       3Q      Max 
-2.28679 -0.58051 -0.09022  0.55610  2.10678 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.0000   0.0000  
 Residual             0.3987   0.6315  
Number of obs: 53, groups:  id, 15

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)
(Intercept)      1.41867    1.74184 49.00000   0.814    0.419
factor(season)2  0.02221    0.19408 49.00000   0.114    0.909
factor(season)3 -0.28557    0.25936 49.00000  -1.101    0.276
height           0.01603    1.15509 49.00000   0.014    0.989

Correlation of Fixed Effects:
            (Intr) fct()2 fct()3
factr(ssn)2  0.067              
factr(ssn)3  0.330  0.405       
height      -0.997 -0.121 -0.371
```

Chapter 5 Appendix

1. Model BMI

BMI = BFP benefit management + income/capita + agegroup/gender + % kcal requir. + (season|id)

Using Shapiro normality test, errors come from normally distributed population (W=0.97, p<0.1)

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: bmi ~ factor(bfp_m) + incomehh + gend + kcal_pc + (season | id)
   Data: Ch6_data_pc_fx

REML criterion at convergence: 324.6

Scaled residuals: 
     Min       1Q   Median       3Q      Max 
-1.90945 -0.29247 -0.02845  0.31132  1.75723 

Random effects:
 Groups   Name        Variance Std.Dev. Corr 
 id       (Intercept) 7.1806   2.6797        
          season      0.3044   0.5517   -0.44
 Residual             0.1586   0.3983        
Number of obs: 99, groups:  id, 38

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)    
(Intercept)     30.682158   1.463431 33.690000  20.966  < 2e-16 ***
factor(bfp_m)PM  0.558260   1.250167 32.080000   0.447  0.65820    
factor(bfp_m)PW  2.083359   0.940481 32.360000   2.215  0.03390 *  
incomehh        -0.018450   0.005994 32.080000  -3.078  0.00424 ** 
gendF           -7.895066   1.015204 32.240000  -7.777 6.84e-09 ***
gendM           -8.708499   0.909013 32.380000  -9.580 5.68e-11 ***
kcal_pc         -0.002212   0.002981 51.210000  -0.742  0.46148    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW incmhh gendF  gendM 
fctr(bf_)PM -0.299                                   
fctr(bf_)PW  0.140  0.204                            
incomehh    -0.853  0.157 -0.432                     
gendF       -0.227 -0.104 -0.007  0.006              
gendM       -0.233  0.036 -0.045 -0.031  0.390       
kcal_pc     -0.166 -0.030  0.026 -0.010 -0.069 -0.028
```

2. Model BMI – only adult women’s data

BMI = BFP benefit management + income/capita + (1|id)

Using Shapiro normality test, errors come from normally distributed population (W=0.97, p=0.94)

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: bmi ~ factor(bfp_m) + incomehh + (1 | id)
   Data: Ch5_data_A

REML criterion at convergence: 306.5
```

```
Scaled residuals:
     Min       1Q   Median       3Q      Max 
-1.88981 -0.61108  0.06933  0.50859  1.96747 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 26.07872 5.1067  
 season   (Intercept)  0.03316 0.1821  
 Residual              0.26117 0.5111  
Number of obs: 89, groups:  id, 31

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)    
(Intercept)     30.17547    2.37360 27.11200  12.713 6.15e-13 ***
factor(bfp_m)PM -0.10590    2.53072 27.00300  -0.042   0.9669    
factor(bfp_m)PW  3.67769    2.14692 27.01900   1.713   0.0982 .  
incomehh        -0.01576    0.00912 27.00800  -1.728   0.0954 .  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW
fctr(bf_)PM -0.280              
fctr(bf_)PW -0.155  0.391       
incomehh    -0.800 -0.069 -0.300
```

3. Model Sum of skinfolds– only adult women’s data

Sum of skinfolds = BFP benefit management + income/capita + (1|id)

Using Shapiro normality test, errors come from normally distributed population (W=0.98, p=0.23)

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: sumfold ~ factor(bfp_m) + incomehh + (1 | id)
   Data: Ch5_data_A

REML criterion at convergence: 168.2

Scaled residuals:
     Min       1Q   Median       3Q      Max 
-2.84630 -0.46330  0.01175  0.38338  1.94921 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.741081 0.86086 
 season   (Intercept) 0.009919 0.09959 
 Residual             0.124573 0.35295 
Number of obs: 89, groups:  id, 31

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)  
(Intercept)      1.123222   0.414591 27.827000   2.709   0.0114 *
factor(bfp_m)PM -0.033813   0.437946 26.976000  -0.077   0.9390  
factor(bfp_m)PW  0.528066   0.372318 27.216000   1.418   0.1674  
incomehh        -0.003224   0.001579 27.057000  -2.042   0.0510 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW
fctr(bf_)PM -0.278
```

```
fctr(bf_)PW -0.152  0.392
incomehh    -0.793 -0.069 -0.302
```

4. Model Weight-for-Height– only adolescent's data

Weight-for-height = BFP benefit management + % kcal requir.+ percent income BFP + gender +(season|id)

Using Shapiro normality test, errors **do not** come from normally distributed population (W=0.95, p=0.02)

The assumption of normality of errors was violated for this model, and transformations on the dependent variable were not successful in meeting this assumption. The model was considered sufficient given that Linear Mixed Models have been demonstrated to be robust is some cases (e.g. Jacqmin-Gadda et al. 2007), and errors are concentrated on zeros. However, to address this shortcoming of some of the models, improved approaches will be considered in further publications. One possible approach, suggested by statisticians from Statistical Center at IU is to use a modified count data model, such as hurdle models (e.g. Mullahy 1986).

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: wfh ~ factor(bfp_m) + kcal_pc + bfp_pc + gend + (1 | id) + (1 |
season)
   Data: Ch6data_Ado_pc

REML criterion at convergence: 50

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.67964 -0.46339  0.00323  0.33196  2.93045

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.140174 0.37440
 season   (Intercept) 0.008683 0.09318
 Residual             0.048954 0.22126
Number of obs: 55, groups:  id, 22; season, 3

Fixed effects:
                  Estimate Std. Error         df t value Pr(>|t|)
(Intercept)     -0.7929656  0.3509637 25.5900000  -2.259   0.0326 *
factor(bfp_m)PM -0.0808591  0.2705089 16.9800000  -0.299   0.7686
factor(bfp_m)PW  0.3490150  0.1964464 18.0800000   1.777   0.0925 .
kcal_pc         -0.0005954  0.0013958 47.0700000  -0.427   0.6716
bfp_pc           1.4598643  0.5922852 17.3200000   2.465   0.0244 *
gendM           -0.0611199  0.1812085 17.6600000  -0.337   0.7399
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW kcl_pc bfp_pc
fctr(bf_)PM -0.131
fctr(bf_)PW -0.501  0.256
kcal_pc     -0.501 -0.005  0.118
bfp_pc      -0.744 -0.133  0.320  0.078
gendM       -0.442  0.164 -0.003  0.119  0.126
```

5. Model Sum of skinfolds– only adolescent's data

Sum of skinfolds = BFP benefit management + % kcal requir.+ percent income BFP + gender +(season|id)

Using Shapiro normality test, errors do come from normally distributed population (W=0.98, p=0.44)

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: sumfold ~ factor(bfp_m) + bfp_pc + gend + kcal_pc + (season |      i
d)
   Data: Ch6data_Ado_pc

REML criterion at convergence: 38.5

Scaled residuals:
     Min       1Q   Median       3Q      Max
-1.32436 -0.30682 -0.04077  0.36797  1.81366

Random effects:
 Groups   Name        Variance Std.Dev. Corr
 id       (Intercept) 0.13419  0.3663
          season      0.04498  0.2121   -0.50
 Residual             0.01705  0.1306
Number of obs: 56, groups:  id, 22

Fixed effects:
                  Estimate Std. Error         df t value Pr(>|t|)
(Intercept)     -0.7384746  0.2938740 20.3700000  -2.513   0.0205 *
factor(bfp_m)PM -0.4119776  0.2323101 14.7900000  -1.773   0.0968 .
factor(bfp_m)PW  0.0523138  0.1683317 15.4400000   0.311   0.7601
bfp_pc           0.7807992  0.5055654 14.8400000   1.544   0.1435
gendM           -0.1912393  0.1547424 15.1700000  -1.236   0.2353
kcal_pc          0.0005025  0.0011818 41.6900000   0.425   0.6729
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW bfp_pc gendM
fctr(bf_)PM -0.161
fctr(bf_)PW -0.524  0.266
bfp_pc      -0.743 -0.137  0.310
gendM       -0.430  0.175  0.003  0.123
kcal_pc     -0.482  0.049  0.154  0.042  0.046
```

6. Model Total daily Kcal – mothers and adolescent’s data

Total daily Kcal = BFP benefit management + income/capita + agegroup/gender + (1|id)

Using Shapiro normality test, errors **do not** come from normally distributed population (W=0.97, p=0.05)

The assumption of normality of errors was violated for this model, and transformations on the dependent variable were not successful in meeting this assumption. The model was considered sufficient given that Linear Mixed Models have been demonstrated to be robust is some cases (e.g. Jacqmin-Gadda et al. 2007), and errors are concentrated on zeros. However, to address this shortcoming of some of the models, improved approaches will be considered in further publications. One possible approach, suggested by statisticians from Statistical Center at IU is to use a modified count data model, such as hurdle models (e.g. Mullahy 1986).

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: kcal ~ factor(bfp_m) + incomehh + gend + (1 | id)
   Data: Ch6_data_pc_fx

REML criterion at convergence: 1581.7

Scaled residuals:
```

```
    Min      1Q  Median      3Q     Max 
-1.7206 -0.5263 -0.0648  0.4199  3.1920 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 377903   614.7   
 Residual             266899   516.6   
Number of obs: 104, groups:  id, 38

Fixed effects:
                  Estimate Std. Error        df t value Pr(>|t|)    
(Intercept)      1761.7380   409.3430   28.3750   4.304 0.000181 ***
factor(bfp_m)PM  188.3688   354.8561   28.4810   0.531 0.599651    
factor(bfp_m)PW -174.0340   269.9982   29.9350  -0.645 0.524112    
incomehh           0.1573     1.7061   28.8240   0.092 0.927170    
gendF            374.5543   290.4557   29.3600   1.290 0.207277    
gendM            450.2016   260.3933   29.7640   1.729 0.094183 .  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW incmhh gendF 
fctr(bf_)PM -0.308                            
fctr(bf_)PW  0.146  0.212                     
incomehh    -0.865  0.153 -0.433              
gendF       -0.240 -0.114 -0.018  0.007       
gendM       -0.234  0.029 -0.048 -0.037  0.386
```

7. Model % daily Kcal requirements – mothers and adolescent's data

% daily Kcal = BFP benefit management + income/capita + gender + (1|id)

Using Shapiro normality test, errors **do not** come from normally distributed population (W=0.94, p<0.001)

The assumption of normality of errors was violated for this model, and transformations on the dependent variable were not successful in meeting this assumption. The model was considered sufficient given that Linear Mixed Models have been demonstrated to be robust is some cases (e.g. Jacqmin-Gadda et al. 2007), and errors are concentrated on zeros. However, to address this shortcoming of some of the models, improved approaches will be considered in further publications. One possible approach, suggested by statisticians from Statistical Center at IU is to use a modified count data model, such as Hurdle models (e.g. Mullahy 1986).

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: kcal_pc ~ factor(bfp_m) + incomehh + gend + (1 | id)
   Data: Ch6_data_pc_fx

REML criterion at convergence: 974.7

Scaled residuals: 
     Min       1Q   Median       3Q      Max 
-1.82223 -0.51801 -0.05677  0.43199  2.95195 

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 843.5    29.04   
 Residual             527.8    22.97   
Number of obs: 104, groups:  id, 38

Fixed effects:
                Estimate Std. Error       df t value Pr(>|t|)    
(Intercept)     83.03421   19.12363 28.34000   4.342 0.000163 ***
```

```
factor(bfp_m)PM  8.40666   16.57666 28.44600   0.507 0.615967
factor(bfp_m)PW -8.14842   12.59843 29.79400  -0.647 0.522726
incomehh         0.00283    0.07968 28.75500   0.036 0.971908
gendF           23.73053   13.55884 29.27500   1.750 0.090562 .
gendM           10.41212   12.15185 29.62900   0.857 0.398414
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW incmhh gendF
fctr(bf_)PM -0.308
fctr(bf_)PW  0.146  0.212
incomehh    -0.865  0.153 -0.433
gendF       -0.240 -0.113 -0.017  0.007
gendM       -0.235  0.029 -0.048 -0.037  0.386
```

8. Model Total % daily Kcal from manioc flour – mothers and adolescent's data

% daily Kcal from manioc flour = BFP benefit management + income/capita + gender + %daily kcal requirement + (season|id)

Using Shapiro normality test, errors do come from normally distributed population (W=0.98, p=0.09)

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: far_pc ~ factor(bfp_m) + incomehh + gend + kcal_pc + (season |
id)
   Data: Ch6_data_pc

REML criterion at convergence: 758.5

Scaled residuals:
     Min       1Q   Median       3Q      Max
-2.00687 -0.43418  0.01029  0.40061  3.07299

Random effects:
 Groups   Name        Variance Std.Dev. Corr
 id       (Intercept) 146.31   12.096
          season       22.58    4.752   -0.92
 Residual              62.21    7.887
Number of obs: 104, groups:  id, 38

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)
(Intercept)      12.39834    4.67667  38.63000   2.651   0.0116 *
factor(bfp_m)PM   2.21621    3.51739  28.84000   0.630   0.5336
factor(bfp_m)PW   0.90412    2.60678  32.00000   0.347   0.7310
incomehh         -0.02437    0.01617  29.49000  -1.507   0.1424
gendF            -8.04531    2.96010  30.23000  -2.718   0.0108 *
gendM           -22.59546    2.64978  31.63000  -8.527 1.05e-09 ***
kcal_pc           0.18731    0.03006  73.94000   6.231 2.57e-08 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW incmhh gendF  gendM
fctr(bf_)PM -0.212
fctr(bf_)PW -0.018  0.246
incomehh    -0.720  0.144 -0.324
gendF       -0.059 -0.103 -0.034 -0.036
gendM       -0.158  0.030 -0.083 -0.020  0.396
kcal_pc     -0.551 -0.087  0.072  0.019 -0.208 -0.098
```

9. Model Total % daily Kcal from fish – mothers and adolescent's data

% daily Kcal from fish = BFP benefit management + income/capita + gender + %daily kcal requirement + (season|id)

Using Shapiro normality test, errors do come from normally distributed population (W=0.98, p=0.16)

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: fish_pc ~ factor(bfp_m) + incomehh + gend + kcal_pc + (season |
id)
   Data: Ch6_data_pc

REML criterion at convergence: 615.3

Scaled residuals:
     Min       1Q   Median       3Q      Max
-2.16510 -0.56439 -0.08427  0.41923  2.56743

Random effects:
 Groups   Name        Variance Std.Dev. Corr
 id       (Intercept) 30.468   5.520
          season       5.464   2.337    -1.00
 Residual             17.903   4.231
Number of obs: 104, groups:  id, 38

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)
(Intercept)      6.625073   1.858928 58.540000   3.564 0.000735 ***
factor(bfp_m)PM -1.687850   1.336761 51.430000  -1.263 0.212413
factor(bfp_m)PW  0.635128   1.009595 54.380000   0.629 0.531923
incomehh        -0.014165   0.006173 52.280000  -2.295 0.025798 *
gendF           -1.396260   1.132771 52.380000  -1.233 0.223227
gendM           -1.044028   1.023724 54.500000  -1.020 0.312313
kcal_pc          0.052042   0.013101 69.820000   3.972 0.000171 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW incmhh gendF  gendM
fctr(bf_)PM -0.183
fctr(bf_)PW -0.024  0.247
incomehh    -0.690  0.139 -0.333
gendF       -0.039 -0.101 -0.051 -0.032
gendM       -0.132  0.029 -0.091 -0.022  0.399
kcal_pc     -0.601 -0.110  0.087  0.019 -0.214 -0.113
```

10. Model Total % daily Kcal from fried bananas – mothers and adolescent's data

% daily Kcal from fried bananas = BFP benefit management + income/capita + gender + %daily kcal requirement + (1|id)

Using Shapiro normality test, errors do **not** come from normally distributed population (W=0.95, p<0.001)

The assumption of normality of errors was violated for this model, and transformations on the dependent variable were not successful in meeting this assumption. The model was considered sufficient given that Linear Mixed Models have been demonstrated to be robust is some cases (e.g. Jacqmin-Gadda et al. 2007), and errors are concentrated on zeros. However, to address this shortcoming of some of the models, improved approaches will be considered in further publications. One possible approach, suggested by statisticians from Statistical Center at IU is to use a modified count data model, such as hurdle models (e.g. Mullahy 1986).

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: banana_pc ~ factor(bfp_m) + incomehh + gend + kcal_pc + (1 |
id)
   Data: Ch6_data_pc

REML criterion at convergence: 785.2

Scaled residuals:
    Min      1Q  Median      3Q     Max
-1.4393 -0.6915 -0.1085  0.4643  3.1088

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept)   0.0     0.00
 Residual             125.8    11.22
Number of obs: 104, groups:  id, 38

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)
(Intercept)     -5.398009   4.676001 97.000000  -1.154   0.2512
factor(bfp_m)PM -3.057844   3.409674 97.000000  -0.897   0.3720
factor(bfp_m)PW -5.644438   2.545837 97.000000  -2.217   0.0289 *
incomehh         0.003847   0.015723 97.000000   0.245   0.8073
gendF            0.523394   2.886539 97.000000   0.181   0.8565
gendM           -0.503499   2.586125 97.000000  -0.195   0.8460
kcal_pc          0.164732   0.032540 97.000000   5.062 1.97e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW incmhh gendF  gendM
fctr(bf_)PM -0.191
fctr(bf_)PW -0.029  0.245
incomehh    -0.696  0.142 -0.326
gendF       -0.042 -0.106 -0.050 -0.035
gendM       -0.120  0.033 -0.084 -0.032  0.400
kcal_pc     -0.589 -0.103  0.089  0.017 -0.209 -0.131
```

11. Model Total % daily Kcal from vegetable oil – mothers and adolescent’s data

% daily Kcal from vegetable oil = BFP benefit management + income/capita + gender + %daily kcal requirement + (season|id)

Using Shapiro normality test, errors do **not** come from normally distributed population (W=0.96, p<0.01)

The assumption of normality of errors was violated for this model, and transformations on the dependent variable were not successful in meeting this assumption. The model was considered sufficient given that Linear Mixed Models have been demonstrated to be robust is some cases (e.g. Jacqmin-Gadda et al. 2007), and errors are concentrated on zeros. However, to address this shortcoming of some of the models, improved approaches will be considered in further publications. One possible approach, suggested by statisticians from Statistical Center at IU is to use a modified count data model, such as hurdle models (e.g. Mullahy 1986).

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: oil_pc ~ factor(bfp_m) + kcal_pc + incomehh + gend + (season |
id)
```

```
   Data: Ch6_data_pc

REML criterion at convergence: 662.8

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.4219 -0.5756 -0.1046  0.4467  3.3662

Random effects:
 Groups   Name        Variance Std.Dev. Corr
 id       (Intercept)  1.9923  1.411
          season       0.1406  0.375    1.00
 Residual             31.9585  5.653
Number of obs: 104, groups:  id, 38

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)
(Intercept)     -2.008710   2.742820 32.520000  -0.732    0.469
factor(bfp_m)PM -1.839089   2.050543 23.400000  -0.897    0.379
factor(bfp_m)PW  0.135266   1.513495 26.780000   0.089    0.929
kcal_pc          0.082785   0.018193 66.930000   4.550 2.32e-05 ***
incomehh        -0.001188   0.009428 24.180000  -0.126    0.901
gendF            0.576482   1.730224 24.440000   0.333    0.742
gendM           -0.197792   1.539574 26.390000  -0.128    0.899
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW kcl_pc incmhh gendF
fctr(bf_)PM -0.208
fctr(bf_)PW -0.029  0.244
kcal_pc     -0.562 -0.088  0.087
incomehh    -0.712  0.145 -0.320  0.015
gendF       -0.052 -0.108 -0.042 -0.207 -0.037
gendM       -0.131  0.034 -0.080 -0.129 -0.031  0.400
```

12. Model Total % daily Kcal from highly industrialized foods – mothers and adolescent’s data

% daily Kcal from vegetable oil = BFP benefit management + income/capita + gender + %daily kcal requirement + (season|id)

Using Shapiro normality test, errors do **not** come from normally distributed population (W=0.94, p<0.001)

The assumption of normality of errors was violated for this model, and transformations on the dependent variable were not successful in meeting this assumption. The model was considered sufficient given that Linear Mixed Models have been demonstrated to be robust is some cases (e.g. Jacqmin-Gadda et al. 2007), and errors are concentrated on zeros. However, to address this shortcoming of some of the models, improved approaches will be considered in further publications. One possible approach, suggested by statisticians from Statistical Center at IU is to use a modified count data model, such as hurdle models (e.g. Mullahy 1986).

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: g3_pc ~ factor(bfp_m) + incomehh + gend + kcal_pc + (season |
id)
   Data: Ch6_data_pc

REML criterion at convergence: 711

Scaled residuals:
    Min      1Q  Median      3Q     Max
```

```
-2.6994 -0.4753 -0.0733  0.3068  3.5053

Random effects:
 Groups   Name        Variance Std.Dev. Corr
 id       (Intercept) 69.692   8.348
          season       1.084   1.041    -1.00
 Residual             37.532   6.126
Number of obs: 104, groups:  id, 38

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)
(Intercept)     -7.389041   4.625530 38.810000  -1.597 0.118278
factor(bfp_m)PM -0.639786   3.679565 28.940000  -0.174 0.863174
factor(bfp_m)PW  5.533074   2.686992 31.440000   2.059 0.047838 *
incomehh         0.002161   0.016862 29.290000   0.128 0.898895
gendF            5.271972   3.068909 30.450000   1.718 0.095975 .
gendM            4.250573   2.731818 31.160000   1.556 0.129819
kcal_pc          0.098795   0.025593 94.560000   3.860 0.000207 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Correlation of Fixed Effects:
            (Intr) f(_)PM f(_)PW incmhh gendF  gendM
fctr(bf_)PM -0.240
fctr(bf_)PW -0.005  0.245
incomehh    -0.757  0.149 -0.318
gendF       -0.096 -0.105 -0.018 -0.038
gendM       -0.196  0.031 -0.072 -0.021  0.391
kcal_pc     -0.472 -0.076  0.048  0.014 -0.186 -0.065
```

13. Model height-for-age – only adolescent's data

Height for age = BFP benefit management + % kcal requir.+ percent income BFP + gender +(season|id)

Using Shapiro normality test, errors do come from normally distributed population (W=0.98, p=0.59)

```
Linear mixed model fit by REML
t-tests use  Satterthwaite approximations to degrees of freedom ['lmerMod']
Formula: haz ~ factor(bfp_m) + incomehh + kcal_pc + gend + (1 | id)
   Data: Ch6data_Ado_pc

REML criterion at convergence: 98.2

Scaled residuals:
    Min      1Q  Median      3Q     Max
-2.2484 -0.4995  0.1464  0.5663  1.5781

Random effects:
 Groups   Name        Variance Std.Dev.
 id       (Intercept) 0.52588  0.7252
 Residual             0.08475  0.2911
Number of obs: 55, groups:  id, 22

Fixed effects:
                 Estimate Std. Error        df t value Pr(>|t|)
(Intercept)     -1.447450   0.628256 19.700000  -2.304   0.0323 *
factor(bfp_m)PM  0.130368   0.506250 16.730000   0.258   0.7999
factor(bfp_m)PW  0.040692   0.363972 17.240000   0.112   0.9123
incomehh        -0.001214   0.002362 16.700000  -0.514   0.6141
kcal_pc          0.004110   0.001993 44.790000   2.062   0.0450 *
gendM            0.154305   0.334614 17.020000   0.461   0.6505
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

```
Correlation of Fixed Effects:
             (Intr) f(_)PM f(_)PW incmhh kcl_pc
fctr(bf_)PM -0.349
fctr(bf_)PW -0.017  0.255
incomehh    -0.791  0.140 -0.304
kcal_pc     -0.329  0.001  0.089 -0.039
gendM       -0.359  0.181 -0.055  0.013  0.087
```

Ana Carolina Barbosa de Lima

Curriculum Vitae

EDUCATION

2017 (July) Ph.D in Anthropology
Indiana University Bloomington (IUB)
Departmental minor in Food Studies and outside minor in Social Science Research Methods.

2013 M.A. in Anthropology
Indiana University Bloomington (IUB)
Departmental minor in Food Studies and outside minor in Social Science Research Methods.

2011 M.A. in Latin American Studies
University of Florida (UF)
Specialization in Tropical Conservation Development.

2007 B.S. in Agriculture Engineering
University of São Paulo (USP)

PROFESSIONAL APPOINTMENTS

2008 Field Researcher
Entropix Engineering Company
Planned and implemented evaluation projects for forest and agricultural socio-environmental certification schemes in forest extractivist reserves, forest plantations and coffee farms.

GRANTS

2016 Grant-in-Aid of Doctoral Research Award
Granted by Indiana University Graduate School.

2016 SBE Doctoral Dissertation Research Improvement Grant (Award number BCS-1357325)
Granted by the National Science Foundation, Arlington, VA.

2015 Doctoral Studies Scholarship in Anthropology of Food (Award number 201929/2012-0)
Granted by the National Council of Scientific Development (CNPq), Brazil.

2013 Summer Institute for Research Design Grant
Granted by the National Science Foundation, Arlington, VA.

2012 College Graduate Fellowship in the PhD Program in Anthropology at IU
Granted by the Graduate Division of the College of Arts and Sciences and the Department of Anthropology's David C. Skomp Fellowship Fund, Bloomington, IN.

2011 Graduate Assistantship in the Master Program in Latin American Studies at UF
Granted by the Center for Latin American Studies, University of Florida, Gainesville, FL.

2010 Graduate Fellowship in Environmental and Sustainable Development
Granted by The Compton Foundation, Inc, Redwood City, CA.

2005 Undergraduate Scholarship in Technical Junior Research
Granted by the National Council of Scientific Development (CNPq), Brazil.

PUBLICATIONS

Brondízio ES, **De Lima AC**, S Schramski, and C Adams. 2016. "Social and health dimensions of climate change in the Amazon". *Annals of Human Biology*. 43 (4): 405-14.

Araújo PC, **De Lima AC**, JR Silva, FP Rocha, AM Steward, and RO Macedo. 2015. "Preliminary survey of plants with animal feed potential using an adapted free listing method with cattle ranchers in Amanã Reserve. *Cadernos de Agroecologia*. 10(3):1-6.

De Lima AC. 2014. "Flavors of the city: access to regional fruit and fruit consumption in the State of Acre, Brazil". *Boletim Do Museu Paraense Emílio Goeldi. Ciências Humanas*. 9 (1): 79-92.

De Lima AC, Keppe ALN, FE Maule, G Sparovek, MC Alves, and RF Maule. 2009. *Does certification make a difference? Impact assessment study on FSC/SAN certification in Brazil*. Piracicaba, SP: Imaflora.

De Lima AC, Da Silva EG, G Sparovek, GL Sturion, MFM Precoppe, MLR Meira, MHF Spoto, SO Moraes. 2006. *Manual of solar dehydration of fruits, vegetables, and herbs*. Piracicaba, SP: ESALQ – Divisão de Biblioteca e Documentação (Série Produtor Rural, 33).

PRESENTATIONS IN EVENTS

Oral Presentations

Society for Applied Anthropology Annual Meeting 2017, Santa Fe, NM, USA, 2017.
Title: Family cash transfers in the rural Brazilian Amazon: consequences to diets and health.

Society for Applied Anthropology Annual Meeting 2015, Pittsburgh, PA, USA, 2015.
Title: Family cash transfers and food, household strategies in a Sustainable Development Reserve.

Society for Applied Anthropology Annual Meeting 2013, Denver, CO, USA, 2013.
Title: Healthy eating and the Bolsa Família in the Brazilian Amazon.

International Public Affairs Organization Conference, Bloomington, IN, USA, 2013.
Title: CCTs in Latin America, A case study of Bolsa Família and Chile Solidario (presentation prepared in collaboration with Aviva Elzufon).

Society for Applied Anthropology Annual Meeting 2012, Baltimore, MD, USA, 2012.
Title: Cities and Fruit Consumption in the Brazilian Amazon.

Conference of the Society for Amazonian and Andean Studies, Gainesville, FL, USA, 2010.
Title: Rural to Urban Migration and Changes in Food Consumption in Western Amazonia.

XIII International Symposium of USP, Piracicaba ,SP, Brazil, 2005.
Title: "Sun and Fruit Project": Family Farmers' Agro Ecological Crop Production and Fruit Dehydration (presentation prepared in collaboration with EG da Silve, G. Sparovek, GL Sturion, MFM Precoppe, MLR Meira, MHF Spoto, and SO Moraes).

Poster Presentations
115 th American Anthropological Association Meeting, Denver, CO, USA, 2015.
Title: Family cash transfers and physical status of mothers and adolescents in the rural Brazilian Amazon (presentation prepared in collaboration with Ana C. S. Nascimento).

Seminar for Conservation and Development in the Tropics, Tefé, AM, Brazil, 2014.
Title: Preliminary results of food pantry inventories of Amanã Reserve communities.

Working Forests in the Tropics Conference, Gainesville, FL, USA, 2008.
Title: Forest Certification Impacts on Community Forest Management in Brazilá Western Amazon (with Gerd Sparovek as first author, ALN Keppe, and RF Maule).

ACADEMIC SERVICE
Reviewer**,** Book Chapter entitled "Riverine households: Resource management foundation" in *The science of Pirarucu management in the Amazon: theory and practice* (in press). 2017. Mamirauá Sustainable Development Institute. Ellen Amanal, Nelissa Peralta and Caroline Arantes (Editors).

Reviewer**,** Ecology and Society: A journal of integrative science for resilience and sustainability. 2016. Lance Gunderson, Carl Folke (Editors-in-Chief).

Reviewer**,** African Journal of Biotechnology. 2014. George Nkem Ude, N. John Tonukari (Editors-in-Chief).

Organizer**,** Indiana University – AGSA Symposium Committee. Planned a half-day workshop for undergraduate students on presenting a professional research article. February 13th, 2013.

Organizer**,** Indiana University – AGSA Member. Organized and participated in a peer-review Research Writing Group for graduate students during the Spring semester of 2013.

Treasurer**,** Tropical Conservation Development Student Group, University of Florida, 2010.

Secretary**,** Tropical Conservation Development Student Group, University of Florida, 2009.

Secretary**,** "Luiz de Queiroz Student Academic Center", University of São Paulo, 2002.

Volunteer Instructor**,** "cursinho do CALQ". Taught English to low income students preparing to apply for University. This was a year program organized by the "Luiz de Queiroz" Student Union, University of São Paulo, 2001.